County Silver Bow
Facility & # Butte #20
Closure
Finan Assur
GW Corr Meas
GW Monitoring
GW Reports
Inspections
Other: Corrective Measures Assessment/Closure Final
Landfarm
Liner
Methane
O & M
Run - On

2/5/97
FINAL

BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES ASSESSMENT

TIME TO COMPLIANCE BSB LANDFILL

DATA/ASSUMPTIONS

Tailing

n =	0.3	porosity
Sw =	0.6	saturation of tailing
Sirr =	0.12	specific retention
Kv =		veritical hydraulic conductivity
dh/dl =	1	gradient
h =	25	depth of tailing

Aquifer

Kh =	283.5	ft/day for Kh = 1x 10-1 cm/s
Kh =	2.835	ft/day for Kh = 1x 10-3 cm/s
dh/dl =	0.0425	gradient
h =	25	depth of aquifer
w =	800	width
i =	1500	length
A =	1200000	surface area
n =	0.25	porosity

Vol of Water in Aquifer underlying VOC plume

Vw = V*n	7500000	cu. ft
V = A*h =	30000000	cu. ft.
Vw =	4112500	cu. ft. This is the volume of water from the consultant

Flow rate through Aquifer

q = KhAdh/dl

q =	240975	cu. ft./day for Kh = 1x 10-1 cm/s
q =	2410	cu. ft./day for Kh = 1x 10-3 cm/s

Time required for Water to Drain from Tailings to Aquifer

v = Kv(dh/dl) average velocity of water draining tailing

v =	.708 ft/day	for Kv = .25 x 10-3 cm/s
v =	.0708 ft/day	for Kv = .25 x 10-4 cm/s
t =	35 days	for Kv = .25 x 10-3 cm/s
t =	353 days	for Kv = .25 x 10-4 cm/s

Time required to flush 1 pore volume of water through aquifer

t = vol of water/ flow rate

t =	31	days for Kh = 1x 10-1 cm/s
t =	3112	days for Kh = 1x 10-3 cm/s
t =	17	days for Kh = 1x 10-1 cm/ "Time using consultants volume
t =	1707	days for Kh = 1x 10-3 cm/s

Time required to flush 5 pore volumes of water through aquifer

t = vol of water/ flow rate

t =	156	days for Kh = 1x 10-1 cm/s
t =	15562	days for Kh = 1x 10-3 cm/s
t =	85	days for Kh = 1x 10-1 cm/ "Time using consultants volume
t =	8533	days for Kh = 1x 10-3 cm/s

TIME TO IMPROVEMENTS TO WATER QUALITY DOWNGRADIENT OF TIMBER BUTTE SED BAS						
DATA/ASSUMPTIONS						
Tailing						
n =	0.3	porosity				
Sw =	0.6	saturation of tailing				
Sirr =	0.12	specific retention				
Kv =		veritical hydraulic conductivity				
dh/dl =	1	gradient				
h =	25	depth of tailing				
Aquifer						
Kh =		horizontal hydraulic conductivity				
dh/dl =	0.0425	gradient				
h =	25	depth of aquifer				
w =	375	width				
i =	525	length				
A =	196875	surface area				
n =	0.25	porosity				
Vol of Water in Aquifer underlying sed basin						
Vw = V*n	1230469					
V = A*h =	4921875					
Flow rate through Aquifer						
q = KhAdh/dl						
q =	2372097	cu. ft./day	for Kh = 1x 10-1 cm/s			
q =	23720	cu. ft./day	for Kh = 1x 10-3 cm/s			
Time required for Water to Drain from Tailings to Aquifer						
v = Kv(dh/dl)		average velocity of water draining tailing				
v =	.708 ft/day	for Kv = .25 x 10-3 cm/s				
v =	.0708 ft/day	for Kv = .25 x 10-4 cm/s				
t =	35 days	for Kv = .25 x 10-3 cm/s				
t =	353 days	for Kv = .25 x 10-4 cm/s				
Time required to flush one pore volume through aquifer under Timber Butte Sed Basin						
t = vol of water/ flow rate						
t =	.5 days	for Kh = 1x 10-1 cm/s				
t =	52 days	for Kh = 1x 10-3 cm/s				

TIME TO COMPLIANCE CLARK TAILING

DATA/ASSUMPTIONS

Tailing

n =	0.3	porosity
Sw =	0.6	saturation of tailing
Sirr =	0.12	specific retention
Kv =		veritical hydraulic conductivity
dh/dl =	1	gradient
h =	25	depth of tailing

Aquifer

Kh =	283.5	ft/day	for Kh = 1x 10-1 cm/s
Kh =	2.835	ft/day	for Kh = 1x 10-3 cm/s
dh/dl =	0.0425	gradient	
h =	25	depth of aquifer	
w =	1100	width	
i =	1500	length	
A =	2395800	surface area	
n =	0.25	porosity	

Vol of Water in Aquifer underlying Clark Tailing + LAO Tailing

Vw = V*n	14973750	cu. ft
V = A*h =	59895000	cu. ft.

Flow rate through Aquifer

q = KhAdh/dl

q =	331341	cu. ft./day	for Kh = 1x 10-1 cm/s
q =	3313	cu. ft./day	for Kh = 1x 10-3 cm/s

Time required for Water to Drain from Tailings to Aquifer

v = Kv(dh/dl) average velocity of water draining tailing

v =	.708 ft/day	for Kv = .25 x 10-3 cm/s
v =	.0708 ft/day	for Kv = .25 x 10-4 cm/s
t =	35 days	for Kv = .25 x 10-3 cm/s
t =	353 days	for Kv = .25 x 10-4 cm/s

Time required to flush 1 pore volume of water through aquifer

t = vol of water/ flow rate

t =	45	days for Kh = 1x 10-1 cm/s
t =	4519	days for Kh = 1x 10-3 cm/s

Time required to flush 5 pore volumes of water through aquifer

t = vol of water/ flow rate

t =	226	days for Kh = 1x 10-1 cm/s
t =	22596	days for Kh = 1x 10-3 cm/s

DEPARTMENT OF ENVIRONMENTAL QUALITY

MARC RACICOT, GOVERNOR

STATE OF MONTANA

(406) 444-2544

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HELENA, MONTANA 59620-0901

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COMMUNITY SERVICES BUREAU

February 6, 1997

Ron Bertram
Remedial Project Manager
United States Environmental Protection Agency
Region VIII Montana Office
301 S. Park, Drawer 10096
Helena, MT 59626

RE: DEQ comments on LAO Work Plan Addendum 1, ARCO, Jan. 1997

Ron:

DEQ received the noted document February 3, 1997 and summarizes comments in this letter. The work plan is quite brief and only provides minimal details. Of particular note is the absence of any discussion concerning the excavation and disposal of over excavated tailings. Also, ARCO refers to activities at LAO as remedial. Because that connotates a final action, they should reference this work as a removal action.

3.0 Objectives

Third paragraph, ARCO provides some brief justifications of less short term risk for hauling to the Clark tailings. ARCO has used these same arguments in other alternative evaluations; however, their evaluation is fairly surficial considering that the haul rate to the Clark Tailings

will be greater than the haul rate to the Opportunity Ponds. Whether or not this result in less short term risk is uncertain to DEQ.

Third paragraph, ARCO states, "The placement of the LAO materials at the Clark Tailings will benefit the community by providing redevelopment of the site as a recreational facility." This is a round about way of ARCO saying that with the new disposal site they save enough money to build the recreational complex. However, DEQ doesn't believe that it is appropriate for ARCO to state this. The complex could be built regardless of the disposal site location and the decision to identify the Clark Tailings as the new disposal site is independent of the complex.

A section that discusses design changes at LAO should be included. This section would discuss the excavation and disposal of over excavated materials, and would also identify the criteria that ARCO will be required to follow for segregating suitable material for the low permeability cap. Finally, if the agencies are considering any other immediate changes to the LAO work plan final design, it might be suitable to include them in this addendum.

Please give me a call if you have questions.

Sincerely

Kevin Kirley

Kevin Kirley
State Project Officer

cc: Pat Crowley, DEQ

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445, BUTTE, MONTANA 59702 PHONE (406) 782-5177 FAX (406) 782-5866

January 15, 1997

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DEPT. OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION

F. Patrick Crowley
Solid Waste Regulatory Lead
Solid Waste Program, Permitting and Compliance Division
Montana Department of Environmental Quality
P.O. Box 200901
Helena, Montana 59620-0901

RE: FINAL DRAFT OF BSB LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES

Dear Pat:

Attached is one copy of the Final Draft, Butte-Silver Bow Landfill/Clark Tailings Corrective Measures Assessment for your review. This report is being submitted on behalf of Butte-Silver Bow. If you have any questions or need additional copies of the report, please give me a call. We look forward to meeting with you to discuss the report and the status of gaining approval for placing the LAO materials at the Clark Tailings.

Sincerely,

Brad Archibald

Brad Archibald, P.E.

Attachment

cc: James Johnston, BSB Public Works
Gary Keeler, BSB Public Works
Chuck Stilwell, ARCO
Ron Ziegler, ARCO
Robin Bullock, ARCO
Bill Duffy, PMH&S
Bob Fox, EPA
Neil Marsh, MDEQ
Jon Sesso, BSB Planning
Rick Larson, BSB Health
Eric Jacobsen, ARCO
Sandy Stash, ARCO
Dianne Smith, ARCO
Ron Bertram, EPA
Jim Harris, EPA

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2/5/97

FINAL DRAFT

BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES ASSESSMENT

Prepared for:

Mr. James E. Johnston
Director of Public Works
Butte-Silver Bow County
Courthouse
Butte, Montana 59701

JANUARY 1997

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Revised 2/5/97 AP Conley

FINAL DRAFT

BUTTE-SILVER BOW LANDFILL/CLARK TAILINGS CORRECTIVE MEASURES ASSESSMENT

Prepared for:

Mr. James E. Johnston
Director of Public Works
Butte-Silver Bow County
Courthouse
Butte, Montana 59701

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WATER QUALITY DIVISION
JAN 17 1997
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Prepared by:

Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, Montana 59702

JANUARY 1997

EXECUTIVE SUMMARY

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County/Department of Public Works (BSB) from Pat Crowley of the Montana Department of Environmental Quality (MDEQ)/Remediation Division, Solid Waste Program notifying BSB that the fourth quarter groundwater monitoring results for the Old Butte-Silver Bow Sanitary Landfill (Old Landfill) exceeded the groundwater protection standards for certain constituents of concern (CoCs) listed on Table 2 of Administrative Rules of Montana Title 17, Chapter 50, Subchapter 7, Section 8 (ARM 17.50.708). In the same letter, MDEQ notified BSB that additional sampling was required to be conducted during the first quarter of 1995, and that preparation of a Corrective Measures Assessment was to be completed. This document was prepared to specifically satisfy these requirements.

Pursuant to the agreement reached between MDEQ, the U. S. Environmental Protection Agency (EPA), BSB, Inland Properties, Inc., and the Atlantic Richfield Company (ARCO), the Old Landfill and the adjacent Clark Tailings will be addressed as one unit (hereinafter referred to as the site), since the two sites are contiguous and have similar anticipated end land uses.

A draft corrective measures assessment was submitted to MDEQ in May of 1995. Since that time, additional site characterization data have been collected. Also, BSB and ARCO have participated in on-going correspondence and meetings with MDEQ regarding closure of the site. This correspondence included discussions regarding placing materials excavated from the Lower Area One (LAO) Operable Unit Phase I, Segment II Expedited Response Action (located approximately one mile north of the site) at the Clark Tailings, under the authority of the MDEQ, Solid Waste Program. MDEQ has expressed agreement with these plans, in concept, and will approve of the plan pending resolution of a few details. (Discussions and correspondence regarding these details are on-going between MDEQ, ARCO, and BSB.) Therefore, the evaluation of alternatives, and the selection of the preferred alternative, is based on the LAO materials being placed at the site.

The objective of this assessment of corrective measures is to identify economically and technically viable alternatives for closing the Old Landfill/Clark Tailings site that will minimize potential threats to human health and the environment. The site history, setting, and available data are presented and analyzed. Remedial technologies are identified and screened. Finally, technologies are organized into viable alternatives, which are screened and then evaluated in detail. Ultimately, a preferred alternative is identified.

The Old Landfill is located approximately one mile southwest of the city of Butte and covers approximately 62 acres. The landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDEQ in 1978. The landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill located at Rocker). Some construction and demolition debris is still disposed at the site by BSB contractors, as

approved by MDEQ. In the summer of 1994, final cover installation, in accordance with the landfill's closure plan, was started. As of December 1996, 55 of the 62 acres requiring closure had received final cover.

The Clark Tailings cover approximately 60 acres and are located directly east of the Old Landfill. The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The Clark Tailings were reclaimed in the mid-1980's as part of the "Clark Tailings Erosion Control Project", by the Anaconda Minerals Company. While much of the area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface. Vegetative growth on the Clark Tailings is sporadic due to the inconsistent cover thickness.

Future land use plans for the Old Landfill/Clark Tailings site are outlined in the BSB Land Use Master Plan. The future land use is designated as open space/recreational. Current zoning precludes residential development on the site. The recreational uses may specifically include the development of athletic fields, park settings, golfing, and other outdoor recreational facilities.

Groundwater monitoring at the site has detected the presence of contaminants at concentrations exceeding groundwater protection standards in wells beneath the site. Based on statistical analyses, some inorganic and organic constituents were identified as CoCs in wells within the site. Since the submittal of the draft corrective measures report, new wells have been installed at the downgradient boundary of the contiguous site. Selected inorganics exceed groundwater protection standards in some of these wells. Sampling of wells downgradient of the site have not detected CoCs at concentrations exceeding groundwater protection standards.

Corrective measures goals for the site are defined primarily by solid waste regulations. Landfill closure regulations at ARM 17.50.530 (for portions of the site which received wastes after October 9, 1991) and MDEQ guidance (for portions of the site that stopped receiving wastes prior to October 9, 1991) contain provisions governing capping of solid waste disposal units. Groundwater protection standards for the site are defined at ARM 17.50.708(5) and require that groundwater protection standards are not exceeded at or beyond the point of compliance. The point of compliance is defined as the a point not more than 150 meters downgradient of the waste management unit and on property owned by the owner of the waste management unit.

Based on the available information, reclamation technologies and process options applicable to the site were identified and screened. Remaining technologies and process options were assembled into alternatives, which were developed, analyzed, and evaluated based on effectiveness, implementability, and cost. Results of the analysis are summarized on Table ES-1.

Based on the results of the detailed analysis, Alternative 8 - Landfill Gas Removal with Capping and Institutional Controls was identified as the preferred alternative. This alternative includes importing the LAO materials to the Clark Tailings portion of the site and consolidating surficial wastes from the periphery of the tailings. The cap over the landfill will be completed in

accordance with regulatory requirements. A low permeability soils cap, also in accordance with regulatory requirements, will be installed over the Clark Tailings. Run-on and runoff controls will be implemented, including GCL-lined ponds south of the Clark Tailings and at the Timber Butte Sedimentation Basin, to minimize leachate generation and erosion. The alternative also includes venting of landfill gas to control the source of organic contaminants. Also, institutional controls, including controls on groundwater and land use and a long-term groundwater monitoring program, will be implemented to further protect human health and the environment. After implementation of the corrective measures, the site will be developed as a recreational facility.

LAO materials will be imported and placed at the Clark Tailings in 1997 and 1998. The Clark Tailings cap will be installed as areas are filled to grade and will be completed in 1998. Capping of the landfill, including installation of the gas venting system, will be completed in 1997. Groundwater monitoring of the site will continue as required by the regulations. The recreational complex at the site will be developed after capping activities are completed.

TABLE ES-1
ALTERNATIVE SCREENING SUMMARY

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 1: No Action	No additional action is taken at the site. Site would remain with landfill only partially capped and Clark Tailings cap partially eroding.	Protection of human health and the environment is not achieved. Not effective at satisfying landfill closure requirements.	Not applicable.	There is no cost associated with this alternative.	This alternative will be retained for comparison of other alternatives as suggested by the NCP.
Alternative 2: Institutional Controls	A fence would be installed around the site to prevent access. Land and groundwater use restrictions would be implemented.	Not effective at satisfying landfill closure regulations. Effective at reducing exposure to COCs.	Access restrictions implementable, but contradict with community's end use plans for the site. GWCA implementable through BSB Water Quality District and DNRC.	Present worth value of $513,614, includes $158,510 in capital costs and $23,100 in annual O&M costs.	This alternative will not be considered further as a stand alone alternative.
Alternative 3: Native Materials Capping	Native materials caps installed to satisfy landfill closure regulations. Run-on/run-off controls installed. Long-term groundwater monitoring would be implemented.	Effective at satisfying landfill closure regulations and preventing direct contact. Cap will decrease amount of surface water infiltration through wastes.	Technically and administratively feasible. Compatible with final use plans for the site.	Present worth value of $1,437,523, includes $1,065,510 in capital costs and $24,200 in annual O&M costs.	Alternative is implementable and potentially effective; however may not adequately address VOCs and will not prevent exposure. Therefore, it will be retained for further consideration.

TABLE ES-1
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 4: Native Materials Capping with Institutional Controls	Land and groundwater use restrictions implemented in addition to native materials cap described in Alternative 3.	Effective at satisfying landfill closure regulations. May not satisfy all regulations pertaining to closure of the Clark Tailings after the LAO materials are imported. Will reduce infiltration and leachate generation, but may not control landfill gases and VOC groundwater contamination.	Technically and administratively implementable. Materials are available locally. Applies conventional construction techniques. Implementation of controlled groundwater will require involvement of BSB Water Quality District and DNRC.	Present worth value of $1,574,737 includes $1,135,085 in capital costs and $28,600 in annual O&M costs.	Alternative is effective and implementable. While it may not achieve all regulatory standards, it will prevent exposure to COCs. It will be retained for further consideration.
Alternative 5: Low Permeability Capping with Institutional Controls	Native materials cap satisfying regulatory requirements installed over landfill portion of the site. A low permeability cap, satisfying closure regulations (ARM 17.50.530) installed over Clark Tailings. Land and groundwater use restrictions implemented.	Effective at satisfying closure regulations for the landfill and Clark Tailings portion of the site. Will reduce infiltration and leachate generation, but may not control landfill gases and VOC groundwater contamination.	Technically and administratively implementable. Materials are available locally. Applies conventional construction techniques. Implementation of controlled groundwater will require involvement of BSB Water Quality District and DNRC.	Present worth value of $2,989,136 includes $2,498,755 in capital costs and $31,900 in annual O&M costs.	Alternative is effective and implementable. It may not achieve GWPS for VOCs, but it will prevent exposure to COCs. It will be retained for further consideration.

TABLE ES-1
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 6: Multimedia Capping with Institutional Controls	A multimedia cap, consisting of native soils, a geosynthetic clay liner, and a flexible membrane liner would be installed to minimize infiltration through wastes. Institutional controls may also be implemented to control groundwater use.	Effective at preventing contact with COCs and minimizing surface water infiltration. Not certain if alternative would be effective at addressing groundwater contamination.	Technically and administratively implementable. Applies conventional materials and construction techniques.	Present worth value of $8,451,279 includes $7,960,898 in capital costs and $31,900 in annual O&M costs. Present worth rises to $8,015,000 if institutional controls are added.	Alternative is effective for inorganics, but not expected to be effective for VOCs. Therefore, due to effectiveness comparable to less expensive alternatives, this alternative will not be retained for further analysis.
Alternative 7: Vertical Groundwater Barriers with Capping and Institutional Controls	An upgradient slurry wall and hydrodynamic controls installed in addition to native soils cap and institutional controls.	Effectiveness of slurry wall uncertain. Soils cap and institutional controls effectiveness same as Alternative 4.	Cap and institutional controls implementable. Implementability of an effective slurry wall uncertain.	Present worth value of $3,950,723 includes $3,386,785 in capital costs and $36,685 in annual O&M costs.	Alternative's effectiveness and Implementability are questionable. Due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.

TABLE ES-1
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 8: Landfill Gas Removal with Capping and Institutional Controls	Same as Alternative 5 with addition of passive gas vents installed over a portion of the landfill.	Gas venting expected to be effective at addressing VOC contamination. Capping and institutional controls will be effective at addressing inorganic contamination. Will satisfy all regulatory requirements.	Technically feasible and readily implementable. Uses conventional technology and readily available materials construction expertise. Alternative is conducive with future land use plans.	Present worth value of $3,067,566 includes $2,577,185 in capital costs and $31,900 in annual O&M costs.	This alternative is expected to be effective and implementable. Therefore, it will be retained for detailed analysis.
Alternative 9: Groundwater Removal and Treatment with Capping and Institutional Controls	Same as Alternative 4 with addition of groundwater removal (via extraction pumps) and treatment (via air stripping and ion exchange).	Capping and institutional controls will be effective at controlling inorganics, but may not satisfy all regulatory requirements. Groundwater removal not expected to be effective because of heterogeneous aquifer setting.	Technically implementable. Discharge of water will require a MPDES permit.	Present worth value of $6,091,949 includes $1,881,435 in capital costs and $273,900 in annual O&M costs.	Effectiveness is questionable. Due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.
Alternative 10: In Situ Groundwater Treatment with Capping and Institutional Controls	Same as Alternative 4 with addition of in situ groundwater treatment via air sparging.	Capping and institutional controls will address inorganics, and air sparging will be effective at controlling VOCs. Capping may not satisfy all regulatory requirements.	Technically and administratively implementable. However, air sparging may exacerbate landfill gas migration.	Present worth value of $3,159,239 includes $2,435,505 in capital costs and $47,080 in annual O&M costs.	Alternative is potentially effective and implementable. However, air sparging may lead to landfill gas migration problems. Also, no more effective than other alternatives that are less costly more easily implemented. Therefore, this alternative will not be retained for further analysis.

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1.0 INTRODUCTION

On December 23, 1994, a letter was received by Gary Keeler of Butte-Silver Bow County (BSB)/Department of Public Works from Pat Crowley of the Montana Department of Environmental Quality (MDEQ, formerly the Montana Department of Health and Environmental Sciences)/Remediation Division, Solid Waste Program notifying BSB that the fourth quarter groundwater monitoring results for the Old Butte-Silver Bow Sanitary Landfill (hereinafter referred to as the "Old Landfill") exceeded the groundwater protection standards (GWPSs) for certain constituents of concern (CoCs) listed on Table 2 of Administrative Rules of Montana Title 17, Chapter 50, Subchapter 7, Section 8 (ARM 17.50.708) (Attachment 1). In the same letter, MDEQ notified BSB that additional sampling was required to be conducted during the first quarter of 1995, and that preparation of a Corrective Measures Assessment (CMA) was to be completed. Additionally, the letter suggested combining the closure of the Old Landfill with the Clark Tailings since the two sites are contiguous and have similar anticipated end land use. Therefore, pursuant to the agreement reached between MDEQ, the U.S. Environmental Protection Agency (EPA), BSB, Inland Properties, and the Atlantic Richfield Company (ARCO), the Old Landfill and the adjacent Clark Tailings will be addressed as one contiguous unit under solid waste regulations.

A draft CMA was submitted in May of 1995. Since the submittal of the draft CMA, BSB and ARCO have been conducting additional site characterization efforts to fill the data gaps identified in the draft CMA. During these characterization efforts, BSB and ARCO have frequently met and corresponded with MDEQ to ensure the efforts met regulatory requirements. Also, plans to import materials from the Lower Area One (LAO) Phase 1, Segment II Expedited Response Action to the Clark Tailings have been developed. These plans will allow for more timely completion of the LAO reclamation activities. The regulatory agencies overseeing the LAO removal activities have agreed in concept with the plans to transport the materials to the Clark Tailings pending approval of the MDEQ, Solid Waste Program. (ARCO will submit an addendum to the LAO Expedited Response Action Work Plan/Design Report to EPA concurrently with the submission of this document to MDEQ.) Also, the projected final end use of the combined site as a recreational complex has been refined. This document is an update to the draft CMA. It reflects the comments on the draft CMA provided by MDEQ, the additional data collected since the draft report was issued; the plans to import LAO materials to the Clark Tailings prior to closure of the Clark Tailings; and the projected final use of the combined site.

1.1 ASSESSMENT OBJECTIVES

This CMA addresses the Old Landfill and the adjacent Clark Tailings. The combined Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1). The purpose of this CMA is to summarize available information and consider potential corrective measures for these two adjacent sites.

The Clark Tailings are located immediately east of the Old Landfill (Figure 1-1). Based on letters received from EPA and MDEQ (Attachments 2 and 3), the Clark Tailings are no longer considered a part of the Butte Priority Soils Operable Unit (BPSOU) of the Silver Bow

1.0 INTRODUCTION

Creek/Butte Area National Priorities List (NPL) site. However, remediation of the sites will be consistent with the goals and objectives of the Superfund process. Therefore, the selected remedy will be addressed as a "completed" site in the BPSOU Record of Decision. The Clark Tailings were reclaimed in the 1980's by the Anaconda Company under the Clark Tailings Erosion Control Project. However, final land-use for the site was not resolved at that time.

The corrective measures at both the Old Landfill and the Clark Tailings must consider future land use plans for the sites, which are detailed in the BSB Land Use Master Plan. The plan designates the area as open space/recreational. Therefore, BSB plans to develop the combined site as a recreational complex after closure.

The objective of this assessment of corrective measures is to identify viable site closure alternatives that will minimize potential threats to human health and the environment and satisfy regulatory requirements. First, the site history, setting, and available data are presented and analyzed. Next, remedial technologies are identified and screened. Then, technologies are organized into viable alternatives, which are screened and then evaluated in detail. Ultimately, a preferred alternative is selected [per ARM 17.50.710(7)(b)], which:

- is protective of human health and the environment;
- attains the GWPSs at ARM 17.50.710(5);
- controls the sources of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of Table 2 [ARM 17.50.708] constituents of concern into the environment that may pose a threat to human health or the environment;
- complies with the standards for management of wastes specified at ARM 16.14.710(8); and
- is approved by MDEQ.

1.2 REPORT ORGANIZATION

This CMA is designed to satisfy the requirements of ARM 17.50.710(6). To accomplish this, it has been organized into the sections listed in the following paragraphs. The contents of each section are briefly described.

SECTION 2.0 SITE BACKGROUND AND PHYSICAL SETTING - presents a background description of the Old Landfill and the Clark Tailings. Significant site features; history of past landfilling and tailings disposal and reclamation activities; geologic, hydrologic and climatic characteristics of the sites; the biological setting, such as the wildlife and fisheries resources and the vegetation indigenous to the area; and threatened and endangered species concerns, as well as the cultural setting issues, such as present and future land uses, are described in this section.

SECTION 3.0 WASTE CHARACTERISTICS - describes the characteristics of the wastes present at the site, including types, volumes, and contaminant concentrations, as well as an evaluation of existing data derived from previous investigations and response actions.

SECTION 4.0 SUMMARY OF CORRECTIVE MEASURES GOALS - presents the remediation goals for the site, including solid waste regulations in the ARM and other performance standards utilized for the Butte area as part of previous CERCLA activities.

SECTION 5.0 CONTAMINANT ASSESSMENT AND CONCEPTUAL SITE MODEL - presents and analyzes the environmental data available for the site and identifies CoCs. Where appropriate, the effect of cleanup standards discussed in Section 4.0 on the objectives of the corrective measures is discussed.

SECTION 6.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES - identifies and screens potentially applicable remediation alternatives. Alternatives are evaluated and screened based on the requirements of ARM 16.14.708.

SECTION 7.0 DETAILED ANALYSIS OF ALTERNATIVES - presents a detailed analysis of the corrective measures alternatives.

SECTION 8.0 COMPARATIVE ANALYSIS OF ALTERNATIVES - presents a comparative analysis of alternatives consistent with the National Contingency Plan (NCP).

SECTION 9.0 PREFERRED ALTERNATIVE - presents the preferred alternative and summarizes the reasoning behind the choice of this alternative.

SECTION 10.0 CORRECTIVE MEASURES GROUNDWATER MONITORING PLAN - describes a monitoring plan for the site intended to assess the effectiveness of the corrective measures alternative implemented at the site.

SECTION 11.0 PROJECT SCHEDULE - presents the proposed project schedule for the design and implementation of the preferred corrective measure.

SECTION 12.0 PROJECT MANAGEMENT PLAN - details how the project will be managed and tracked from the completion of CMA through construction of the selected remedial alternative and post-construction monitoring.

SECTION 13.0 COMMUNITY RELATIONS PLAN - describes how the community will be involved in the selection of the preferred alternative and informed of project progress, in accordance with the requirements of ARM 16.14.708(6)(d).

SECTION 14.0 REFERENCES - provides references for technical and regulatory citations in the document.

2.0 SITE BACKGROUND AND PHYSICAL SETTING

2.1 SITE HISTORY

2.1.1 Old Landfill Site

The Old Landfill is located approximately one mile southwest of the city of Butte (Figure 1-1). The landfill is located at approximately 45° 58' 38" North latitude and 112° 33' 05" West longitude. Covering approximately 62 acres, it lies within portions of the SE¼ of Section 26, the SW¼ of Section 25, the NE¼ and the NW¼ of Section 35, and the NW¼ of Section 36 of Township 3 North, Range 8 West in Silver Bow County, Montana.

The Old Landfill opened in approximately 1968 and accepted the municipal solid waste from Butte and it's vicinity. The landfill was issued an operating license by the MDEQ in 1978 (a permit was not required previously). Since 1978, the landfill has been inspected on a regular basis by MDEQ personnel. Landfilling at the site appears to have used a combination of area and trench landfilling methods.

Grove Gulch historically flowed through the northwestern portion of the site. In the early 1980's, a sedimentation basin was constructed immediately west of the Old Landfill by the U.S. Department of Agriculture/Soil Conservation Service (SCS). Discharge from the sedimentation basin was routed generally north of the historic drainage, along the northwest boundary of the landfilled area (Figure 2-1). At the point where the native drainage meets Little Basin Creek Road (near the northern border of the landfill, see Figure 2-1), Grove Gulch enters a 42-inch diameter reinforced concrete pipe (RCP) culvert, which carries the flow underground until it discharges on the eastern side of the old Burlington Northern Railroad grade, approximately 1,700 feet northeast of the Old Landfill and immediately east of the Clark Tailings.

Run-off from the Clark Tailings and the eastern portion of the Old Landfill is currently conveyed, via a constructed ditch between the tailings and the landfill, to the Timber Butte Sedimentation Basin, located in the northeastern portion of the Clark Tailings site (Figure 2-1). This basin is dewatered by a 36-inch diameter, perforated RCP riser. The basin was designed to allow for the sedimentation of solids from the Timber Butte Mill Site, surrounding adjacent lands, and the Clark Tailings during run-off events. The perforated riser connects to the RCP diversion of Grove Gulch discussed above. The drop inlet and ditch were also constructed in the early to mid-1980's.

The Old Landfill stopped receiving municipal solid wastes from the public on March 14, 1994 (with the opening of the new Butte-Silver Bow Sanitary Landfill). Some construction and demolition debris is still disposed at the site by Butte-Silver Bow contractors, as approved by MDEQ (Attachment 4). The construction and demolition debris disposal area is shown on Figure 2-2. The public has not had access to the site for refuse disposal since March 14, 1994.

In winter and spring of 1993, a landfill cover material evaluation was conducted (Braun-Intertec, 1993a and 1993b). In March of 1993, an *Interim Closure Plan for the Butte-Silver Bow Landfill* was prepared (SRM, 1993). Based on the information in these reports, installation of final cover was conducted by the U.S. Forest Service/Anaconda Job Corps in the summers from 1993 to 1996. Currently, approximately 55 of the 62 acres requiring closure have received final cover; of the 55 acres, disturbed areas will be fine graded and seeded in the fall of 1996. The *Interim Closure Plan* had identified those areas that did not receive waste after October 9, 1991, and required a final cap in accordance with Solid Waste Regulations in place at that time (two feet of 1×10^{-3} cm/sec soils). Areas that received wastes after October 9, 1991, require closure in accordance with more stringent EPA regulations that came into effect at that time (including an 18-inch 1×10^{-5} cm/sec infiltration barrier layer and a 6-inch erosion control layer). The closure material evaluation showed that the soils met the 1×10^{-3} cm/sec permeability specification. The cap has been installed on much of this area (55 of 58 acres). Approximately three acres south of the Clark Tailings require some additional cover material placement and grading to satisfy the regulatory standard for pre-1991 disposal areas. The four acres that received waste after October 9, 1991, has not received final cover as of December 1996. This area will be capped after placement of construction and demolition wastes from the nearby Montana Pole Plant remedial action. Capping of this area will be in accordance with the solid waste regulations at ARM 17.50.530(a). The extent of final cover placement is shown on Figure 2-2.

Much of the area in the southeastern portion of the Old Landfill (south of the Clark Tailings) is mounded; historic filling methods led to the erratic development of this portion of the landfill (no final cover has been placed in this area to date by the Job Corps). In this area, it appears that trenches were arbitrarily cut and filled, resulting in the inconsistent topography and drainages. Currently, vegetation over the landfill is sporadic. There are some areas with good vegetative cover, consisting primarily of bunch grasses.

In November of 1990, MDEQ conducted a Preliminary Assessment (PA) of the Old Landfill in accordance with the NCP. The site did not score high enough to be included as a Superfund site. However, MDEQ recommended that the site be investigated further because of the lack of data available at the site and the potential for releases of hazardous substances. The site was classified as a medium priority for a screening-level site investigation.

In July of 1992, BSB was notified by MDEQ that a Hydrogeological and Soils Study, a Groundwater Monitoring Plan, and a Groundwater Sampling and Analysis Plan were required at the Old Landfill (Potts, 1992). Subsequently, a work plan for the Hydrogeological and Soils Study was prepared; it was approved by MDEQ on January 12, 1993 (Potts, 1993). The wells were installed and the initial groundwater sampling event was conducted in the spring of 1993. Well locations are shown on Figure 2-3. Ensuing groundwater sampling events detected constituents on the ARM 17.50.708, Table 1, list of analytes that exceeded specified action levels. Accordingly, assessment monitoring was conducted and subsequent samples were analyzed for Table 2 constituents. Assessment monitoring results showed that GWPSs were exceeded for certain volatile organic compounds (VOCs) and, apparently at that time, thallium. Therefore, as previously stated, on December 23, 1994, this CMA became necessary as required

by ARM 17.50.710(6) (see Attachment 1). Groundwater quality data collected to date are presented in Section 3.1.

A draft CMA was submitted in May of 1995. This draft CMA identified data gaps and plans to fill those gaps. Subsequently, the *Sampling and Analysis Plan (SAP) for the Butte-Silver Bow Landfill/Clark Tailings Assessment of Corrective Measures Investigation* was prepared and approved by MDEQ (Pioneer, 1995). Additional site characterization data were collected and are presented herein.

2.1.2 Clark Tailings

The Clark Tailings consist of an estimated 1,000,000 cubic yards (cy) of mill tailings (Hydrometrics, 1983) covering approximately 60 acres and lie to the east of the Old Landfill (Figure 1-1).

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. The mill was reportedly closed years before it was dismantled (Smith, 1953). During it's years of operation, the mill served primarily as a zinc and copper concentrator. Ore from the Elm Orlu Mine, north of Butte and east of Walkerville, was processed at the mill.

The Clark Tailings were reclaimed in the mid-1980's as part of the "Clark Tailings Erosion Control Project", by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface. There is not an adequate depth of cover soil in portions of the area to sustain vegetative growth. Also, there is evidence that run-off channels have cut through the cover materials into the tailings during run-off events.

Reclamation of the Timber Butte Mill, south of the Clark Tailings, was conducted in 1989.

In early 1996, EPA, MDEQ, ARCO, and BSB began investigating the possibility of placing mill tailings and other materials from the LAO operable unit of the Butte Area National Priorities List (NPL) site at the Clark Tailings. This corrective measures assessment is based on additional tailings materials from LAO being disposed on the Clark Tailings portion of the site.

2.2 CLIMATE

The climatological discussion presented in this section is based on data collected between 1906 and 1990 (Climatological Data, Montana, U.S. Environmental Data Service). The climate in the Butte area is semi-arid. The Butte area is known for it's short, cool summers and cold winters. The average annual temperature in Butte is 39°F, with a high mean monthly temperature of 63°F in July and a low of 15.5°F in January.

The average annual precipitation in Butte in 11.5 inches. Approximately 64% of the precipitation falls between May and September. Historically, the wettest month is June, with an

average of 2.37 inches of precipitation. The driest month is February, with 0.38 inches of precipitation.

According to the Montana Agricultural Potential System (MAPS) database, the annual Penman potential evaporation at the site is 31 inches and the annual Thornwaite potential evapotranspiration is 19.4 inches (MAPS, 1995).

2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

2.3.1 Regional Setting

The discussion of the regional geologic and hydrogeologic setting of the site is based on a Montana Bureau of Mines and Geology (MBMG) bulletin (Botz, 1969).

Butte lies within the Summit Valley, which was formed in the Late Tertiary or Early Quaternary. Eroded materials from the uplands were deposited as quaternary alluvium (along the valley bottom) and colluvium (on upland slopes and hills) as the faulted Summit Valley basin dropped. This depositional material makes up the soils of the Summit Valley, including the area of the Old Landfill and the Clark Tailings. The sediments range from boulders to clay, range from 0 to 800 feet thick, and overlie bedrock. The lithology of the alluvium varies throughout the valley. Generally, as reconstructed from well logs and mine shafts in the area, the lithology consists of 50 to 100 feet of coarse-grained materials overlaying a fairly continuous layer of sandy silt or clay down to a depth of 100 feet below ground surface (bgs) in the area of the landfill (SRM, 1992). These sediments, particularly the clay and silt fractions, have the ability to adsorb and attenuate contaminants that come into contact with them.

Bedrock consists of igneous material associated with the Boulder Batholith (formed during the Cretaceous). Butte Quartz Monzonite (Qmp) constitutes the majority of bedrock under the Butte area, as well as most of the mountains and foothills surrounding the Summit Valley. The bedrock immediately below the alluvium/colluvium in the valley exhibits varying degrees of weathering, fracturing, and faulting. The competent bedrock below the weathered material is regarded as a relatively impermeable unit for all of Summit Valley. The bedrock aquifer has been demonstrated by ARCO to be a low permeability, low production aquifer that cannot be practicably used as a water source in the Summit Valley. This information is included in the Mine Flooding Operable Unit Record of Decision (EPA, 1994a).

Primary groundwater flow direction is patterned after the major surface drainage network in the valley. Depth to groundwater ranges from 11 to 300 feet bgs, with an average of approximately 50 feet (Botz, 1969). Hydraulic properties of the valley sediments are variable. Hydraulic conductivities in the valley are reportedly greatest in the alluvial sediments adjacent to the major surface drainages (Botz, 1969).

Significant, perennial surface water drainages in the Summit Valley are Blacktail Creek and Silver Bow Creek (below it's confluence with Blacktail Creek). Based on U.S. Geological

Survey (USGS) Water Resources Data, Montana, 1984 to 1991, the mean discharge of Blacktail Creek, immediately before it's confluence with Silver Bow Creek, is 10.5 cubic feet per second (cfs). The mean discharge of Silver Bow Creek as it leaves Summit Valley is 22.5 cfs; a significant portion of this flow is the Butte Metro Sewage Treatment Plant discharge, which averages 7.3 cfs. Both of these streams are generally gaining streams through the Summit Valley (ESA, 1991). Grove Gulch, which is diverted around the site, is an intermittent stream which discharges to Blacktail Creek.

2.3.2 Local Geologic Setting

The Old Landfill/Clark Tailings site overlies the western flank of the Quaternary/Tertiary alluvial valley fill in the Summit Valley (Botz, 1969). The landfill monitoring well logs indicate that bedrock was encountered between 30 feet (A3, east) and 60 feet (A1, north) of the surface. Monitoring wells installed at the site indicate that the entire tailings area is probably underlain by alluvium. The underlying bedrock is Cretaceous Butte Quartz Monzonite. Monitoring well locations are shown on Figure 2-3. A geologic cross-section based on these monitoring well logs is shown on Figure 2-4.

2.3.3 Local Hydrogeology

The Old Landfill evidently overlies both the alluvial and bedrock groundwater systems. The northern portion of the landfill and probably most of the Clark Tailings influence the alluvial system. Local static water level measurements from domestic and irrigation wells taken concurrently with one of the landfill groundwater sampling rounds indicate that local groundwater flow travels along the former route (prior to its diversion to the east) of Grove Creek, toward the north-northeast (see Figures 2-5 and 2-6). Transmissivity was measured in the alluvial aquifer at 7,275 ft^2/day at a location 2 miles east-northeast of the landfill site (Botz, 1969). While this is the nearest transmissivity datum available, it appears to be from the Blacktail Creek alluvial aquifer and may not be representative of local conditions.

2.3.4 Local Surface Hydrology

2.3.4.1 Local Drainage

The primary surface water feature in the vicinity of the site is Grove Gulch. This gulch historically cuts across the northwest portion of the landfill property. Grove Gulch is an intermittent stream draining approximately 4.4 square miles (2,800 acres) above the landfill. Most of this drainage basin is semi-arid upland range land. There are some areas disturbed by historic mining prospects. The peak flows associated on different return frequency flow events for this gulch are shown on Table 2-1. These flow values are based on USGS regional regression calculations (Omang, 1992). Note that these are estimated peak flows into the Grove Gulch Sedimentation Pond; peak discharges from the pond will be dampened as a result of the pond's detention capacity.

In the early 1980's, the Grove Gulch Sedimentation Pond was constructed west (upstream) of the Old Landfill and a diversion ditch was installed to route the gulch around the landfill (Figure 2-1). These improvements were designed and installed by the SCS.

The Grove Gulch Sedimentation Pond is equipped with a 12-inch diameter corrugated steel discharge pipe; it is apparent that the capacity of the discharge pipe is exceeded at times and the dam's spillway is used during high flow events. The downstream slope of the dam has been covered with riprap and concrete to prevent erosion.

The sedimentation basin discharges to an earth channel which routes the flow to a diversion inlet approximately 1,200 feet downstream (at Beeftrail Road). According to the SCS design plans, this channel is at an average slope of 0.3%.

The Grove Gulch Diversion consists of a buried 42-inch RCP at a slope ranging from 1.24 to 2.20%. This diversion routes the drainage along the south side of Beeftrail Road for approximately 2,500 feet until it discharges to a plunge pool and ditch on the east side of the Burlington Northern Railroad east of the Clark Tailings, near the Seymour Livestock yard (Figure 2-1). The surface water flow continues to flow through Butte and eventually drains to Blacktail Creek.

The Old Landfill is currently graded to direct surface water run-off from the landfill to adjacent drainages. A small area on the southwestern portion of the landfill (approximately 8 acres) drains to the west, to the Grove Gulch Sedimentation Pond discussed above. A small area (approximately 12 acres) drains to the diversion between the sedimentation pond and the Grove Gulch diversion inlet. The northeastern portion of the landfill is graded such that surface run-off will flow to the northeast, where it will eventually be intercepted by the ditch between the landfill and the Clark Tailings and then routed along Beeftrail Road to the Timber Butte Sedimentation Basin, approximately 1,500 feet northeast of the landfill (Figure 2-1).

The Timber Butte Sedimentation Basin mentioned above was constructed in the early 1980's to address potential concerns (discussed above) about the water quality and quantity from run-off from the Old Landfill and the Clark Tailings.

Run-off from the Clark Tailings is also directed to the Timber Butte Sedimentation Basin. The western portion of the Clark Tailings drains to the existing ditch between the Old Landfill and the tailings and then routed to the basin. The eastern portion of the tailings will drain to the east and northeast to the basin.

The Timber Butte Sedimentation Basin is dewatered by a 36-inch diameter RCP perforated riser. The dewatering structure is perforated below the ground surface to allow for subsurface dewatering of the basin. This drop inlet connects to the Grove Gulch diversion described above. This diversion routes the storm water run-off under the Burlington Northern Railroad grade (Figure 2-1), where it discharges to a plunge pool. From the plunge pool, a ditch continues east and eventually the drainage discharges to Blacktail Creek on the east side of Lexington Avenue.

2.3.4.2 Surface Water Quality

According to environmental documentation prepared by SCS during the planning and design of the Grove Gulch Sedimentation Pond and diversion, water quality in Grove Gulch upgradient of the site is excellent. Water quality changed very little after if flowed through the wooden culvert under the Old Landfill and past the Clark Tailings.

Surface water quality samples were collected above and below the Old Landfill on four occasions in 1991 and 1992 by MBMG personnel. These samples were collected well after the installation of the Grove Gulch Sedimentation Pond and the Timber Butte Sedimentation Basin. One sample location is described as Grove Gulch, above the landfill, and the other is described as Grove Gulch, below the landfill, near Montana Street. This downgradient sampling point would represent the potential contribution by the site to the surface water. It also represents the potential contribution by a substantial area east of the Old Landfill and Clark Tailings, including the railroad right-of-way, a livestock facility, and a trucking facility. The analytical data for these samples are included in Appendix B and are discussed in Section 5.2.

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The Old Landfill/Clark Tailings site is located in portions of Sections 25, 26, 35, and 36 of Township 3 North, Range 8 West in Butte-Silver Bow County, Montana (Figure 1-1). The 130 acre site is located approximately one mile southwest of the city of Butte. The site is on a predominately north facing slope, which averages 4%.

2.4.2 Vegetation and Wildlife

Vegetation at the Old Landfill/Clark Tailings site is inconsistent. Portions of the site, where adequate soil cover has been installed and graded properly, have a healthy stand of bunch grasses typical of the semi-arid upland ranges of the region. Noxious weeds (particularly spotted knapweed) are common on the site and the surrounding area. Portions of the site have little or no vegetative cover. These areas typically have not received adequate soil cover (capable of supporting a vegetative growth), are graded too steeply or have been subjected to erosion.

In the Butte area, the bluebunch wheatgrass (*Agropyron spicatum*)/bluegrass (*Poa* spp.)/rubber rabbitbrush (*Chrysothamnus nauseousus*) plant community is predominant (JMM, 1993). This plant community probably existed at the site before waste disposal activities began. No listed threatened or endangered species are present at the site. The vicinity is mapped as potential habitat for the Prebles shrew, which is currently at U.S. Department Fish and Wildlife Service C2 status (Montana Natural Heritage Program, 1995). C2 is a notice of review status, meaning that proposing to list the species as a threatened or endangered species may be appropriate, but adequate biological information is not available. The species is ranked G4 (apparently secure) within it's range, and S3 (either rare and local or found locally in a restricted range) in Montana.

The shrew is not known to inhabit the area of the site; therefore, any actions taken at the site will not impact known shrew habitat. No aquatic wildlife is present in Grove Gulch, an intermittent stream.

2.4.3 Historic or Archaeologically Significant Features

No historic or archaeologically significant features are known to exist on the site. The Clark Tailings have been reclaimed previously (in the mid-1980's), and as such have already been displaced from their historical setting.

2.4.4 Land Use

2.4.4.1 Current Land Use

Currently, the Old Landfill site is predominately unused. As discussed in Section 2.1.1, the landfill is in the process of being closed, over 85% of the landfill cap has been installed. The entrance to the landfill is posted as closed, with directions to the new landfill west of Butte. A small portion of the landfill is used for the disposal of demolition debris, as approved by MDEQ. This area will remain without final cover until construction and demolition debris from the nearby Montana Pole Plant remedial action is disposed at the Old Landfill in the summer of 1996, as requested by MDEQ. The public does not have access to this disposal area.

The Clark Tailings are not currently in use. Access to the Clark Tailings is controlled via a perimeter fence. The majority of the Clark Tailings were reclaimed in the mid-1980's; however, the reclamation was not successful in some areas and the land has not been used since.

2.4.4.2 Future Land Use

Future land uses must be considered when developing and evaluating corrective measures. The corrective measures selected must support the intended future land use. At the Old Landfill/Clark Tailings site, future land uses are outlined in the BSB Land Use Master Plan. The future land use is designated as open space/recreational. Current zoning precludes residential development on the site. The recreational uses may specifically include the development of athletic fields, park settings, golfing, and other outdoor recreational facilities. Restrictive covenants will be placed upon the site in accordance with ARM 17.50.530 and private party agreements will also limit future land uses.

Mill tailings and contaminated soils from the nearby LAO Operable Unit may be transported to the site to be combined with the Clark Tailings. If this material is imported, it will be placed and capped in a manner conducive to the potential development of recreational facilities at the site.

2.4.5 Groundwater Use

There are no current groundwater extraction wells on the site itself. Most wells downgradient of the site (shown on Figure 2-5) are used for irrigation (including the wells owned by Reap, Blankenship, and the cemetery wells). There are no known drinking water supply wells downgradient of the site. Future groundwater uses may be controlled through institutional controls to prevent exposure to CoCs, depending on the alternative implemented. Groundwater from the vicinity of the site may be used for irrigation at the site if the site is developed as a recreational complex. Monitoring will ensure that groundwater that may pose a threat to human health and the environment will not be used for irrigation.

2.4.6 Surface Water Use

There are no known surface water uses of Grove Gulch downgradient of the site. No surface water rights are registered with the Montana Department of Natural Resources and Conservation (DNRC) for Grove Gulch downgradient of the landfill. If the combined site is developed as a recreational complex, surface water run-off may be collected in decorative/sedimentation ponds. Water from these ponds may be used for irrigation of the recreational complex.

3.0 WASTE CHARACTERISTICS

3.1 OLD BUTTE-SILVER BOW LANDFILL

The Old Landfill served as a municipal solid waste repository from approximately 1968 until it closed in 1994. As such, typical municipal solid wastes (or Group II wastes per MDEQ regulations at ARM 17.50.503) were disposed at the site. The specific quantity of wastes on-site are not known. However, based on an average depth of waste of 15 feet over approximately 60 acres that received wastes, and a 4:1 waste:cover soil ratio, it can be estimated that approximately 1.2 million cy of waste have been disposed at the site. At an estimated average in-place waste density of 1,000 lb/cubic yard (SWANA, 1991), approximately 600,000 tons of refuse have been disposed at the site. This would equal an average generation rate of 4 pounds per capita per day during the life of the landfill. This is consistent with the typical solid waste generation values reported by SWANA (1991), and slightly higher than those reported by McBean, et al (1995).

Wastes landfilled at the site may have led to elevated concentrations of CoCs in localized groundwater, as determined by the groundwater monitoring conducted to date. Groundwater quality data available to date are summarized in Appendix A. Only those constituents which were detected above their instrument detection limit (IDL) in the groundwater samples are included in the data analysis. Sample locations are presented in Figure 2-3.

The following volatile organic contaminants have been detected in the landfill monitoring wells:

- acetone;
- chloroethane;
- 1,4-dichlorobenzene;
- 1,1-dichloroethane;
- cis-1,2-dichloroethene;
- trichloroethene;
- trans-1,2-dichloroethene;
- ethyl benzene;
- m+p xylenes;
- benzene;
- chloromethane;
- dichlorodifluouromethane;
- 1,2-dichloroethane;
- vinyl chloride;
- tetrachloroethene;
- 1,2-dichloropropane;
- 1,1,1-trichloroethane;
- methyl ethyl ketone; and
- napthalene.

Also, some inorganic constituents were detected at concentrations greater than GWPSs. These wells, however, are within or downgradient of the Clark Tailings, and it is expected that the Clark Tailings are the source of the inorganic contaminants, as discussed in Section 3.2. A statistical analysis of the detected groundwater contaminants is presented in Section 5.1.

The natural anaerobic degradation of wastes occurring in the landfill produces landfill gas, predominately methane and carbon dioxide. This landfill gas at the Old Landfill also contains trace amounts of VOCs. As discussed in Section 5.3, the landfill gas is apparently not migrating from the site; however, landfill gas within the Old Landfill contained 1,1-dichloroethane; cis-1,2-dichloroethene; trichlorethene; and tetrachlorethene. The presence of VOCs in landfill gas is also well documented in the literature.

3.2 CLARK TAILINGS

The source of the Clark Tailings was the Timber Butte Mill, which began operation in 1914 and was dismantled in 1948. During it's years of operation, the mill served primarily as a zinc and copper concentrator. Ore from the Elm Orlu Mine, north of Butte and east of Walkerville, was processed at the mill. According to a 1915 paper on the operation of the mill (Simons, 1915), the tailings from the mill contained the following fractions (in parts per million):

- copper: 700;
- silver: 19;
- gold: 0.053;
- iron: 1,400;
- zinc: 12,000;
- lead: 500; and
- insolubles (percent): 95.12.

Much of the ore milled at the Clark Mill was processed for zinc. Greenockite (CdS) was detected in the Butte area by Anaconda Minerals Company geologists, particularly on the periphery of the copper zones. It was often associated with sphalerite (ZnS), which made up the zinc ores of the Elm Orlu and other zinc mines. Therefore, it is anticipated that the Clark Tailings contain some cadmium in addition to the fractions reported above.

There are approximately 1,000,000 cy of Clark Tailings (Hydrometrics, 1983) covering approximately 60 acres. The Clark Tailings were reclaimed in the mid-1980's by the Anaconda Minerals Company. While much of area was regraded, covered, and revegetated, there are many areas where tailings are currently present at the surface.

Per a 1989 EPA Administrative Order on Consent, the CoCs for the Timber Butte Mill Site (the source of the Clark Tailings) were: arsenic, cadmium, lead, zinc, and copper. This Order required a Removal Action at the Mill Site (which was conducted in 1989). The Order mentions reclamation of a drainage immediately east of the Clark Tailings, but did not address the Clark Tailings directly. For purposes of this CMA, the primary CoCs for the Clark Tailings portion of

the site are considered as those from the Timber Butte Site (arsenic, cadmium, copper, lead and zinc).

Four samples collected from the upper two feet of the Clark Tailings have been analyzed for metals content (two samples collected in 1982 and two samples collected in 1987). The following CoC concentration ranges were reported (McCulley, Frick, and Gilman, 1993):

- arsenic 166 to 934 mg/kg;
- copper 314 to 761 mg/kg;
- lead 335 to 1440 mg/kg; and
- zinc 1210 to 4640 mg/kg.

Hydrometrics (1983) reported that one of the samples collected in 1982 contained 35 mg/kg of cadmium, of which 4.64 mg/kg was water soluble. They also reported that a significant fraction of the zinc (397 to 565 mg/kg), manganese (109 to 2375 mg/kg), and arsenic (0.18 to 9.88 mg/kg) in the 1982 samples was water soluble.

During the 1996 CMA investigation, one sample of the Clark Tailings was collected. The sample consisted of a fine quartz sand (tailings) collected from 7.5 to 9.0 feet bgs at BSB-SG1, in the northwestern quadrant of the tailings (the location of this sample is shown on Figure 5-1). The sample was analyzed for metals content and contained the following concentrations of metals:

- arsenic 128 mg/kg;
- cadmium 7.06 mg/kg;
- copper: 676 mg/kg;
- lead: 355 mg/kg; and
- zinc: 2930 mg/kg.

Some metals have been detected in groundwater monitoring wells within and downgradient of the Clark Tailings at concentrations above GWPSs. In particular, cadmium and zinc exceed GWPSs in wells BSB-A6 and CLK-2, respectively. A full statistical analysis of the groundwater contaminants is included in Section 5.1.

In early 1997, 34 test pits were installed around the periphery of the Clark Tailings to determine the extent of the the tailings and to define areas of surficial tailings that could be excavated and consolidated within the rest of the tailings. Test pit locations and logs are included in Appendix F. None of these test pits encountered groundwater. Also, information from soil borings installed as part of previous investigations do not indicate the presence of groundwater within tailings (Hydrometrics, 1983). The monitoring wells at the site also do not indicate that there is groundwater in contact with tailings. Although the groundwater level in well BSB-A6 is apparently near the tailings/alluvium interface, all of the tailings cuttings from the borehole were dry.

4.0 SUMMARY OF CORRECTIVE MEASURES GOALS

In this section, the preliminary corrective measures goals identified for the Old Landfill/Clark Tailings site are discussed. ARM solid waste regulations will dictate most standards for the site. For instance, landfill closure and GWPSs are addressed by the ARM. These goals are summarized in the following sections. The ability of each alternative to meet these corrective measures goals will be evaluated in Sections 6 and 7.

4.1 WASTE MANAGEMENT AREA CLOSURE

For areas that received waste after October 9, 1991, EPA regulations (40 CFR 258.60 and ARM 17.50.530) require that a cap be installed over the landfill at closure. This cap must consist of the following, at a minimum:

- a barrier layer to minimize infiltration, consisting of a minimum of 18 inches of earthen material with a permeability equal to or less than the bottom liner of the landfill or natural subsoils present, or no greater than 1×10^{-5} cm/sec, whichever is less; and
- an erosion control layer, consisting of a minimum of 6 inches of earthen material capable of sustaining native plant growth and protecting the infiltration barrier layer from frost effects and rooting damage.

For areas that stopped receiving waste prior to October 9, 1991, MDEQ published closure requirements and recommendations (MDEQ, April 3, 1991). These guidelines recommend:

- a cover consisting of a minimum of 24 inches of approved soil with a permeability less than or equal to 1×10^{-3} cm/sec;
- contouring of the site to direct run-on and run-off away from the landfilled area; and
- revegetation of the site to minimize water infiltration and prevent erosion.

4.2 GROUNDWATER PROTECTION STANDARDS

GWPSs for the waste units are defined at ARM 17.50.710(5). This regulation states that the GWPS is established at the maximum contaminant level (MCL) established under the Montana groundwater quality standards, for those constituents for which a MCL has been established. If no MCL has been established, the GWPS is established as the background concentration of the constituent (as defined at ARM 17.50.708). In all cases, if the background concentration exceeds the MCL, the background concentration becomes the GWPS.

Alternative GWPSs may be adopted by MDEQ in accordance with ARM 17.50.710(5)(d). For those constituents that do not have a MCL, MDEQ typically adopts the Human Health Standard (HHS) published by the MDEQ in the Water Quality Bureau Circular 7 (WQB-7; MDEQ, 1995).

Therefore, for this assessment of corrective measures, the GWPSs are: the MCL (for those constituents with an MCL); the HHS (for those constituents for which there is no MCL, but there is an HHS); and background (for those constituents for which there is no MCL or HHS).

Per ARM 17.50.710(1)(f), the point of compliance for groundwater standards shall be no more than 150 meters beyond the waste management unit boundary and must be located on land owned by the owner of the disposal unit. BSB is in the process of acquiring the property adjacent to the Old Landfill (the Clark Tailings property) from Inland Properties, and may acquire additional properties east of the Clark Tailings (including the railroad right-of-way). As discussed in Section 2.3.3 and shown on Figures 2-5 and 2-6, local groundwater flow is generally to the north and east. Therefore, the point of compliance for the combined, contiguous waste management area is defined by wells BSB-A1, BSB-A5, CLK-1, and CLK-2 (recently installed at the northeast corner of the Clark Tailings).

4.3 LANDFILL GAS

ARM 17.50.511(f) requires that methane concentrations do not exceed greater than 25% of the lower explosive limit (LEL) in structures or 100% of the LEL at the facility boundary. Monitoring conducted during the soil gas survey (Appendix C) shows that the Old Landfill satisfies these requirements.

The EPA's New Source Performance Standards (NSPS) and emission guidelines (EG) for landfills requires that landfills with a design capacity of greater than 2.5 million metric tons and emit non-methane organic compounds (NMOCs) at a rate greater than 50 metric tons per year must install a landfill gas collection and treatment system. The Old Landfill does not have a design capacity greater than 2.5 million metric tons and does not emit NMOCs at a rate greater than 50 metric tons per year (see Appendix E); therefore, the site does not require an active gas collection system under these rules.

5.0 CONTAMINANT ASSESSMENT AND CONCEPTUAL SITE MODEL

In the following sections, site data are evaluated based on the GWPSs and other corrective measures discussed in Section 4.0. Data were collected via groundwater monitoring at the site and additional site characterization tasks completed as part of this assessment of corrective measures, as described in the SAP (Pioneer, 1995). The corrective measures investigation SAP was approved by MDEQ (Crowley, 1996). CoCs are identified, and the nature and extent of their occurrence at the site is presented. Based on this information, a conceptual site model of the site is developed.

5.1 GROUNDWATER

As required by ARM 17.50.708(12), a statistical analysis of the groundwater quality data for the landfill was conducted to determine if any contaminants were present at concentrations greater than the GWPSs defined at ARM 17.50.710(5). The first step in the analysis was the examination and treatment of below instrument detection limit data; the second step was to compare downgradient groundwater quality to GWPSs. The methodology, rationale, and results of this evaluation is discussed in the following subsections. As long-term monitoring data become available, additional statistical comparisons can be performed.

Groundwater quality data from a geoprobe investigation conducted as part of the assessment characterization are also presented.

5.1.1 Treatment of Below Instrument Detection Limit Data

The first step in the analysis of these data was to account for data reported as below the practical quantitation limit (PQL). The PQL is that level above which the laboratory is able to quantify the amount of a particular constituent. A significant fraction of these data from each sampling event were below these quantitation limits for the analytical method and cannot simply be excluded from the evaluation. These data were treated as specified in the regulation [ARM 17.50.708 (13)(e)] which stipulates that a value equal to one-half the method detection limit (MDL) be used in lieu of detected concentrations for statistical evaluation purposes. The MDL is that level above which the laboratory can report with confidence that a particular constituent is present, but may not necessarily be able to quantify the precise amount. The MDL is typically lower that the PQL. The MDLs for each analyte were reported by the laboratory and are significantly lower than the reported PQLs.

For analytes detected but not quantified below the PQL, one-half the PQL was used. Estimated values (J or E flag) reported by the laboratory were used directly.

The first sampling round, conducted in April of 1993, by SRM, was excluded from the statistical evaluation presented here. This sampling round used different analytical methods, analyzed fewer constituents, and had generally higher PQLs (no MDLs were reported), and hence, were not comparable to the sampling rounds performed after that date. For the above reasons, especially the higher detection limits, these data were not included.

5.1.2 Comparison of Monitoring Well Groundwater Quality to Groundwater Protection Standards

The procedure for evaluating downgradient water quality used the following methodology. For every constituent detected above the MDL during any sampling round and in any well, both the mean and the median concentrations for each downgradient well were calculated. These concentrations were compared with Federal MCLs established by the EPA (both primary and secondary). If no Federal MCL was established, these concentrations were compared with Montana HHSs established by the MDEQ (MDEQ, 1995). If neither Federal MCLs nor Montana HHSs exist, the downgradient well data were compared to the background well data. Collectively, these three concentration comparisons are referred to as GWPSs, as discussed in Section 4.2. In most cases, using this methodology to evaluate downgradient water quality establishes a concentration level that is protective of human health and the environment, as required by ARM 17.50.708(13)(d).

For the comparison to background procedure indicated above, the distribution of analytical data from the background monitoring well (MBMG2) was compared to the data distribution for each of the downgradient wells. As specified in 17.50.708(12)(a), a parametric, one-way analysis of variance (ANOVA) procedure was used, followed by multiple comparison of means. The comparison of means was performed using both the Least Significant Difference (LSD) method (least conservative-allows experimentwise error rate to increase as "n" increases) and Tukey's (F) method (which limits experimentwise error). Tukey's method for the comparison of means is considered the most useful pairwise comparison because it controls the experimentwise error rate (conservative), yet retains good comparison power; therefore, it was used for determining significant differences between downgradient wells and the background well. Experimentwise error was restricted to 0.05, as specified in ARM 17.50.708(13)(b). It is important to note that this ANOVA comparison is significant even at the low number of samples ("n"= 4 or 5) evaluated. The procedure is robust and significant when applied to smaller values of "n", even when other procedures are not valid at the same small "n". Additional measurements will, of course, increase confidence in the comparison results.

The mean and median concentrations for all wells are presented on Table 5-1 (inorganic constituents) and Table 5-2 (organic constituents). Also indicated on these tables are Federal MCLs, Montana HHSs, mean and median concentrations for blank samples, an indication of whether the mean or median for each well exceeds the GWPSs, and analyte MDLs. Three noteworthy observations regarding these tables require further explanation.

First, the mean and median concentration of the background and wells downgradient of the landfill exceed the MCL for thallium. The thallium background mean is 4.2 μg/L and the median is 5.5 μg/L. The downgradient thallium means are <1-7.5 μg/L and the medians are <1-7 μg/L, compared to the MCL of 2 μg/L. Thallium concentrations vary between <1 and 6 μg/L in the blank samples. There apparently is a problem with these thallium analyses. Of the groundwater sampling episodes conducted at the Old Landfill, thallium was detected in the background well on three occasions (the background well was sampled for thallium analysis five times). The

concentration of thallium detected in the background well was consistently higher than the associated MCL, and similar to the concentrations detected in the downgradient monitoring wells. Thallium was also detected in the field blank sample on two occasions.

The background well data indicate that the thallium contamination is not attributable to the Old Landfill or the Clark Tailings. Additionally, when thallium was detected in the field blank sample above the MCL, the results were discussed with the laboratory chemists who analyzed the samples. The laboratory chemists indicated that the thallium detects could possibly be false positives caused by instrument interference due to matrix effects (interference due to organic contaminants present in the samples). As a check on the thallium enigma, split samples were collected at the landfill during February of 1995, to be analyzed by independent laboratories; the results are presented on Table 5-3 and summarized below.

Since the laboratory chemists suggested that the thallium detects may be false positives caused by organic interference, the wells selected for split samples correspond with: 1) no expected organic contaminants in the sample (background well MBMG-2); 2) very few expected organic contaminants in the sample (well BSB-A4); and 3) the highest expected amount of organic contaminants in the sample (well BSB-A2). The split sample data indicate that thallium was consistently detected at a higher concentration by the current laboratory (MSE-HKM) and, in fact, thallium was not detected in any of the samples analyzed by the check laboratory. These data indicate that the current laboratory is possibly the source of the thallium contamination that has been observed in the groundwater samples (possible cross-contamination or poor instrument performance for thallium).

Second, the mean and median concentration of the blank samples for antimony exceed the MCL for antimony; however, none of the wells exceed GWPSs. The antimony blank mean is 6.2 μg/L and the median is 9 μg/L, compared to the MCL of 6 μg/L. Clearly, there is also a problem with the antimony analyses, possibly a filter/tubing contribution. Similar to thallium, antimony has been observed at relatively high concentrations in background well samples, as well as in the field blank sample during several sampling episodes at the landfill.

The background well data indicate that the antimony contamination is not attributable to the Old Landfill or the Clark Tailings. However, as a check on the antimony enigma, split samples were collected at the landfill during February of 1995, to be analyzed by independent laboratories, the results are presented on Table 5-3. The data indicate that antimony is not in close agreement between the two laboratories; in general, antimony was detected at a higher concentration by the current laboratory compared to the check laboratory. As an additional check on the antimony enigma, separate field blank samples were collected during March of 1995, by Pioneer Technical Services. One of the blank samples consisted of deionized water filtered in the field in the usual manner (the same filtering equipment used to filter the groundwater samples), the other blank sample consisted of deionized water transferred directly into the sample container (not filtered). These data presented in Table 5-4 indicate that the antimony contamination is most likely attributable to the filter or the tubing attached to the peristaltic pump used for field filtering. The standard operating procedure for field filtering groundwater samples includes decontamination of

the pump tubing between samples; however, these data indicate that cross-contamination is most likely occurring and the pump tubing should be replaced prior to each sampling episode.

Lastly, well CLK-1 has only been sampled twice. Although two samples are enough to calculate means and medians, the significance of these measures are low and more data are required to verify concentrations. Exceedences for this well should be considered preliminary at this time. Upon collection of additional discrete samples from this well (a total of 4 or 5), more confidence can be applied to the results. Furthermore, well CLK-1 may not be representative of general groundwater quality immediately downgradient of the Clark Tailings. This well is located very close to the outlet of the Grove Gulch Diversion, and local hydrology and groundwater quality may be influenced by the diversion. Also, the well is located downgradient of a railroad grade that may also be influencing groundwater quality. Therefore, an additional groundwater monitoring well downgradient of the Clark Tailings was installed as proposed to and agreed by MDEQ (Lynch and Stash, 1996a). This well (CLK-2) is shown on Figure 2-1. It is in the process of being developed at the time of this writing, and will be sampled in January 1997.

Exceedences of GWPSs (as defined in Section 4.2) were present in downgradient monitoring wells (mean and/or median) for the following inorganic constituents:

- Well BSB-A1: None.
- Well BSB-A2: Cd, Co, Fe, Zn, sulfate, and SC.
- Well BSB-A3: Fe and SC.
- Well BSB-A4: None.
- Well BSB-A5: Sulfate and chemical oxygen demand (COD).
- Well BSB-A6: Cd, Co, Fe, Zn, Sulfate, COD, and SC.
- Well CLK-1: Zn.

Due to the interferences noted above, thallium is not designated as exceeding the GWPS at the site.

Exceedences of GWPSs for the following organic constituents were present in monitoring wells:

- Well BSB-A1: None.
- Well BSB-A2: 1,1-dichloroethane; cis-1,2-dichloroethene; tetrachloroethene; trichloroethene; and vinyl chloride.
- Well BSB-A3: Chloroethane.
- Well BSB-A4: None.
- Well BSB-A5: None.
- Well BSB-A6: 1,1-dichloroethane; cis-1,2-dichloroethene; tetrachloroethene; and trichloroethene.
- Well CLK-1: Not analyzed.

One time groundwater samples were collected during the geoprobe investigation conducted in February of 1996. Data from these samples are included in Appendix C and are summarized on

Table 5-5. Samples from BSB-SG1, BSB-SG11, and BSB-SG12 were analyzed for VOCs. Samples from BSB-SG1 and BSB-SG12 were also analyzed for metals. Sample locations are shown on Figure 5-1. The data show that GWPSs for arsenic and iron were exceeded in BSB-SG1. There were no exceedences of metals standards in BSB-SG12. GWPSs for VOCs were not exceeded at any of these sampling points.

5.1.3 Downgradient Water Quality

To determine if there were significant impacts on downgradient water quality, samples were collected from some of the downgradient water wells shown on Figure 2-5. Samples from the Blankenship, the Crematorium, and cemetery-middle wells (approximately 600, 2,200, and 2,700 feet from the site, respectively) were analyzed for VOCs. Samples from the Reap (approximately 1,500 feet from the site) and Blankenship wells were analyzed for heavy metals. Results are summarized on Table 5-6 and are included in Appendix A. No CoCs from the site were detected above GWPSs in the downgradient wells.

5.1.4 DNAPL Evaluation

During the assessment characterization, a sample was collected from the bottom of well BSB-A3 before purging the well. The sampling procedure is explained in detail in the SAP (Pioneer, 1995). The data from this sample, which was analyzed for VOCs, was compared to the data from the regular sample collected from this well after purging in accordance with groundwater sampling standard operating procedures (SOPs). The comparison showed that the concentrations of VOCs in the two samples were very similar, including cis-1,2-dichloroethane; trichloroethene; and vinyl chloride. (The full data report is included in Appendix C.) This information suggests that there is not a dense non-aqueous phase liquid (DNAPL) plume present at the bottom of well BSB-A3. Had the concentration of VOCs been significantly higher in the DNAPL evaluation sample collected from the bottom of the well before purging, it may suggest the presence of a DNAPL plume.

An attempt was made to collect a DNAPL evaluation sample from the bottom of well BSB-A2, also. However, obstacles in this damaged well made it impossible to advance a bailer to the bottom of the well. Therefore, no DNAPL evaluation sample was collected from this well.

5.2 SURFACE WATER

Available surface water data for the site consist of four samples collected by MBMG personnel between May 15, 1991, and August 20, 1992, and samples collected by the SCS during the planning and design of the Grove Gulch Creek Diversion in the early 1980's.

MBMG personnel collected samples above and below the Old Landfill. The upgradient sampling location is described as Grove Gulch, upgradient of the landfill. The downgradient sampling location is described as Grove Gulch, downgradient of the landfill, near Montana Street. This downgradient sample is not only downgradient of the landfill, but is also

downgradient of a large drainage area east of the landfill, including some portions of Timber Butte, a livestock facility, a trucking facility, and a residential area. Analytical data are included in Appendix B and summarized in Table 5-7. By comparing upgradient to downgradient concentrations, it appears that the site does not significantly degrade surface water quality. While iron and manganese concentrations increase slightly between the upgradient and downgradient sites, the rise could be attributed to contact with steel pipe associated with the Grove Gulch Diversion or other factors. Metals present in the Clark Tailings that are potentially mobile, particularly copper and zinc, do not increase downgradient of the site.

Some metals concentrations from the MBMG data exceed surface water quality standards as defined by the WQB-7 (MDEQ, 1995). The iron HHS of 0.3 milligrams per liter (mg/L) is exceeded at the downgradient location. The downgradient sample means do not exceed the chronic aquatic life standard (CALS) for iron of 1 mg/L. Manganese upgradient and downgradient of the site exceed the HHS of 50 μg/L. There is no CALS for manganese.

Surface water quality data collected by the SCS (reported by Hydrometrics, 1983, and included in Appendix B) indicate that surface water quality in Grove Gulch Creek above and immediately below the site is of comparable quality. Concentrations of arsenic, cadmium, copper, lead, and zinc are comparable just above and just below the combined site (sample locations Grove Gulch 2 and Grove Gulch 5, respectively). Concentrations of iron and manganese have increased below the site. Samples collected from the old (now abandoned) wood and tile flume (sample Grove Gulch 3) contained higher concentrations of some metals, particularly arsenic, copper, lead, and zinc; however, this is apparently due to the entrainment of sediment from the flume with the water sample during sample collection (Hydrometrics, 1983). Samples of run-off from the Clark Tailings also had high concentrations of metals (sample Grove Gulch 4); however, this run-off apparently did not significantly impact surface water quality immediately below the site (sample Grove Gulch 5). Further downgradient of the site (sample Grove Gulch 6, very near the downgradient sample location from the MBMG data set), the concentration of zinc has increased significantly, to levels exceeding acute and chronic aquatic life standards.

High concentrations of solids have been observed at times in run-off from the site (such as during a snowmelt event in February 1996). This run-off is directed toward the Timber Butte Sedimentation Basin. During very large run-off events, the basin fills and discharges to Grove Gulch. This may cause short-term impacts to water quality in Grove Gulch. However, the detention time provided by the basin allows for solids removal via sedimentation, mitigating the impacts to the gulch. The data available do not inidcate any chronic impacts to Grove Gulch from the site.

5.3 LANDFILL/SOIL GAS

The geoprobe investigation of the site included characterization of soil gas and landfill gas at the site. Landfill gas samples were collected from within the landfill boundary, and soil gas samples were collected beyond the landfill border. Landfill gas was sampled to determine if it was

migrating from the site (to ensure compliance with the standards at ARM 17.50.511) and to assess its potential contribution to groundwater contamination.

Soil landfill gas samples were collected from nine locations, shown on Figure 5-1. Samples were analyzed in the field for lower explosive limit (LEL) content (with an O2/LEL meter) and for the VOCs 1,1,1-trichloroethane; cis-1,2-dichloroethene; 1,1-dichloroethane; trichloroethene; and tetrachlorothene (via gas chromatograph). Two split samples were collected and forwarded to Energy Laboratories for VOC analysis via EPA Method 8260. Analytical data are summarized on Table 5-8. The full data report for the laboratory samples is included in Appendix C.

The data show that many of the VOCs in groundwater were also detected during the field analysis of the landfill gas samples, particularly those samples collected from within the landfill (BSB-SG6, SG7, SG8, and SG9). However, the split samples sent to the laboratory did not confirm the presence of these VOCs. The most likely cause of this is the photodegradation of the VOCs between the time they were sampled and analyzed. According to the analytical laboratory, the field data should not be discounted; the VOCs detected by the field gas chromatograph (GC) are most likely present at the concentrations detected in the field (Brown, 1996). This statement is supported by the fact that the water samples split between the field GC and the laboratory correlated very closely for these same constituents (data are included in Appendix C). The soil gas samples collected outside the boundary of the landfill (BSB-SG1, SG4, SG5, SG10, and SG14) show that landfill gas is not migrating from the site. In particular, standards at ARM 17.50.511 are not being exceeded.

5.4 CONCEPTUAL SITE MODEL

The conceptual site model presents the potential routes of human exposure to the waste materials at the site under existing conditions.

Wastes present at the site generally are covered with native soils. However, in some areas of the Clark Tailings cover soils have eroded away and tailings are present at the surface. Therefore, the possibility of exposure, via dermal contact, ingestion, and/or inhalation of airborne particulates, does exist. Access to the site is restricted, however, by a wire-strand fence. Therefore, the current potential to exposure in this manner is limited. However, if the site is developed as a recreational facility, the potential for exposure would increase (with the increased human activity at the site) under existing conditions.

Available surface water quality data (see Section 5.2) indicate that surface water in Grove Gulch is not degraded by the site. However, there is evidence at the site that surface water is cutting through waste materials (including tailings) during run-off events. Discharge from the site enters either the Grove Gulch Sedimentation Pond or the Timber Butte Sedimentation Basin. These structures remove the majority of suspended solids, and associated metals, from the water column. During high flow events, there is the possibility that eroded solids may not be removed from the water column in these sedimentation basins before discharging to Grove Gulch.

GWPSs for some VOCs have been exceeded in wells BSB-A2, BSB-A3 (both immediately downgradient of the landfill), and BSB-A6 (within the Clark Tailings, approximately 450 downgradient of the landfill). Groundwater flow at the site is generally to the northeast, as shown on Figures 2-5 and 2-6. Aquifer materials at the site range from sandy silts to gravelly sands. The two samples of aquifer materials collected at the site (during the installation of well BSB-A5) contained no detectable organic carbon (data are included in Appendix A). Therefore, the capacity of the aquifer materials to attenuate contaminants (both organics and inorganics) is not significant. The groundwater flow velocities vary significantly with the different aquifer materials, and are estimated to range from 1 to 300 feet per year, with an average on the order of 50 feet per year.

While VOCs have been detected in downgradient wells, including BSB-A5, Blankenship's, and the cemetery wells, they do not exceed GWPSs. However, they do exceed GWPSs in the generally cross-gradient well BSB-A6, approximately 400 feet from the landfill boundary.

Based on water balance modeling of the site (performed with the assistance of EPA's Hydrologic Evaluation of Landfill Performance model, see Appendix D) and the watershed above the site, an estimated 9.4 million gallons of water infiltrate through the soils of the basin and become groundwater. Of this, an estimated 18.1% infiltrates through the Old Landfill and 21.5% infiltrates through the Clark Tailings under pre-closure conditions. Groundwater flow, as discussed above, is to the north and east, generally following the topography of the basin.

Based on the data discussed above, the VOC contaminants at the site would be expected to travel toward the downgradient wells (BSB-A5, in particular). However, even though CoCs have been detected in some downgradient wells, no GWPSs have been exceeded beyond the combined site boundary (as determined by the data from wells BSB-A5, Blankenship's, the cemetery wells, and Reap's and the BSB-SG12 geoprobe sampling point). VOCs slightly exceed GWPSs in well BSB-A6 at the landfill's point of compliance. Contaminants present at and near the Old Landfill site boundary (particularly in wells BSB-A2 and BSB-A6) are either degrading (via natural biodegradation), binding to subsurface soils (attenuation), or diluting to the point where GWPSs are not exceeded in downgradient wells. Most likely, it is a combination of these phenomena.

Considering the nature of the wastes at the site, the landfill is the probable source of VOC groundwater contamination. Data collected during the assessment of corrective measures process indicate that landfill gas is the probable source of VOCs in groundwater. VOCs are present at concentrations exceeding GWPSs in well BSB-A2; they are present at much lower concentrations in the downgradient well BSB-A5. However, VOC concentrations exceed GWPSs in well BSB-A6, which is cross-gradient from well BSB-A2. VOCs are present in well BSB-A3, generally upgradient of BSB-A6, but at much lower concentrations. Only one VOC (1, 2-dichloroethane) has been detected, at very low concentrations, in well BSB-A4, also upgradient of BSB-A6. This VOC has also been detected in the upgradient well MBMG-2. Furthermore, many of the VOCs present in groundwater were also detected in landfill gas samples from the site. Most likely, landfill gas is migrating to a point near the eastern border of the landfill, particularly during winter when the ground is frozen and does not allow landfill gas to escape to

the atmosphere. At this point, it is coming into contact with groundwater, and contaminants are being transferred from the gaseous phase to the aqueous phase. The tailings (in the Clark Tailings portion of the site) consist predominately of fine-grained materials which will inhibit the flow of landfill gas. However, as the pressure of landfill gas builds, it will select the path of least resistance to flow through. As a result, there may be selective migration of landfill gas through the Clark Tailings. This model is supported by the fact that after installation of geoprobe point BSB-SG11, a foam was observed rising in the geoprobe hole. The foam, which evidently was caused by landfill gas escaping from the geoprobe hole, was not observed in any of the other geoprobe points that were installed to groundwater. VOC concentrations in BSB-SG11 were greater than any of the other geoprobe sample points. Also, the phenomenon of landfill gas causing VOC contamination of groundwater is well documented (Kerfoot, 1994; BFI, 1995).

The source of inorganic contaminants in groundwater is less clear. Metals have been detected at concentrations exceeding GWPSs in wells BSB-A2 and BSB-A6, both of which were installed through tailings. Cadmium, zinc, iron and other inorganics exceed GWPSs in one or both of these wells (Table 5-1). Also, in well CLK-1, zinc exceeds the GWPS. (This well is also downgradient of the railroad grade in addition to the Clark Tailings.) No exceedences were detected in wells further downgradient of the Clark Tailings. The data available show that the Clark Tailings contain metals, and that a fraction of many of the metals, including cadmium, zinc, and arsenic, are water soluble (Hydrometrics, 1983). Thus, the Clark Tailings are the probable source of metals in groundwater beneath the site. The Elm Orlu mine (the source of many of the tailings at the Clark Tailings) was primarily a zinc mine. Therefore, significant concentrations of zinc would be expected in the tailings. Also, greenockite (CdS) was associated with the zinc ores (sphalerite) on the periphery of the copper zones in Butte. Cadmium would not be expected to float with the concentrate in the Clark Mill; therefore, it is likely that there is cadmium present within the Clark Tailings (Ziehan, 1996). Information available from boreholes and test pits does not indicate that tailings are in direct contact with groundwater. However, infiltrating preciptitation (leachate) may be transferring metals from the tailings to the groundwater. This is particularly true around the Timber Butte Sedimentation Basin. The area of the basin in underlaid by tailings. Surface water run-off from the site is directed to the basin, where the majority is evaporated or infiltrates. Therefore, there is a significant amount of infiltration through the tailings in this area. This may account for the high zinc concentrations in well CLK-1, immediately downgradient of the Timber Butte Sedimenation Basin.

6.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Technology types and corrective measures process options are identified, described, and screened in Section 6.1. In Section 6.2, feasible technologies are assembled and developed as corrective measures alternatives and are subjected to an initial/preliminary screening based on effectiveness, implementability, and cost. The purpose of the initial screening of alternatives is to identify those alternatives appropriate for a subsequent, detailed analysis.

6.1 IDENTIFICATION AND SCREENING OF RECLAMATION TECHNOLOGIES AND PROCESS OPTIONS

The purpose of identifying and screening technology types and process options is to eliminate those technologies that are obviously infeasible due to technical, economic, or other factors while retaining potentially effective options. General response actions are progressively refined into technology types and process options. The process options are screened, and those retained are used to develop corrective measures alternatives. General response actions, technology types, and process options are briefly discussed in this section. General response actions potentially capable of meeting the reclamation objectives are identified in Table 6-1.

In Table 6-2, the screening rationale that was used to eliminate or retain the various corrective measures process options for potential application at the Old Landfill/Clark Tailings site is presented.

6.1.1 No Action

Under the no action option, no future remediation or monitoring would occur at the site. The no action response is a stand-alone response that is used as a baseline against which candidate remedial alternatives are compared.

6.1.2 Institutional Controls

Some institutional controls (deed restrictions) are required under Montana solid waste rules for the closure of the landfill. Upon agreement, deed restrictions are to be recorded with the transfer of land from Inland Properties to BSB for the Clark Tailings site. Land use/zoning restrictions could limit the potential future uses for the land in the event of a sale. Other institutional controls could include access restrictions (fencing) or instituting groundwater use and development restrictions. Institutional controls may be considered alone or in addition to reclamation technologies to accompany other reclamation alternatives.

6.1.3 Containment

Containment is used primarily to reduce the mobility of contaminants by creating a barrier that prevents transport of waste from the contaminated source to the surrounding media. Containment technologies may include capping, revegetation, run-on/run-off control. Other

containment technologies include a variety of technologies designed to prevent the exposure of groundwater to the contaminated media, or the migration of contaminated groundwater from the site.

6.1.4 Removal

Removal involves extracting waste materials from the site to be treated and/or disposed elsewhere. Removal technologies include excavation of solid materials, pumping or bailing of liquids, removal of contaminated groundwater by wells or collection trenches, or extraction of contaminated soil vapors or landfill gases.

6.1.5 Solids Treatment

This general response action involves treating or processing solid-phase waste materials to reduce their volume and/or toxicity. Solids can be treated in situ or after removal. The treated solids can be disposed (on- or off-site) or used in some beneficial manner. Solids can be treated by physical/chemical, thermal, or biological methods. Solids treatment is not implementable at this site due to the volume of wastes present. Therefore, solids treatment options were not included in the reclamation alternatives.

6.1.6 Non-Solids Treatment

Non-solids treatment addresses liquid or gaseous-phase waste materials. The materials are processed or treated to reduce their volume and/or toxicity. Treatment methods include physical methods (such as liquids separation, adsorption, or air stripping); chemical methods (such as neutralization/precipitation); thermal treatment (such as incineration); and biological treatment (such as aerobic oxidation or anaerobic digestion). While most of these technologies require removal of the non-solid media, some can be completed in situ.

6.1.7 Monitoring

Monitoring involves the continued observation and tracking of waste materials at a site. While it does not reduce the volume or toxicity of waste materials, it monitors their setting and ongoing status. In this way, monitoring may be useful if there is no current threat posed by the waste materials, but there is concern that there may be a potential threat in the future. Also, monitoring may be used in conjunction with other general response actions to ascertain their effectiveness.

6.2 DEVELOPMENT AND EVALUATION OF CORRECTIVE MEASURES ALTERNATIVES

Retained technologies and process options are assembled and developed as reclamation alternatives in the following sections. These alternatives do not contain all technologies and process options listed in Table 6-2, but they are considered representative of the remaining process options available. The reclamation alternatives are identified in Table 6-3.

The alternatives are developed and described, and then they are subjected to a preliminary screening based on effectiveness, implementability, and cost. The purpose of this screening is to identify those alternatives appropriate to be retained for subsequent, detailed analysis (Section 7).

The evaluation of effectiveness includes determining the ability of an alternative to address the contamination sufficiently to achieve the corrective measures goals and to provide for overall protection of human health and the environment. The effectiveness screening criteria includes consideration of the nature and extent of the contamination, as well as site-specific conditions, such as geology, hydrology, hydrogeology, climate, and land use. The effectiveness of containment alternatives to prevent the generation of leachate and potential groundwater degradation has been assessed by water balance modeling using the Hydrologic Evaluation of Landfill Performance (HELP) model (EPA, 1994b).

The implementability of each alternative has been evaluated to consider the technical and administrative feasibility of constructing, operating, and maintaining the reclamation alternative. Technical feasibility considerations include applicability of the alternative to the waste source(s), availability of the required equipment and expertise to execute the alternative, and overall reliability of the alternative. Administrative feasibility considerations include logistical and scheduling constraints. The evaluation of implementability also considers appropriate combinations of alternatives with respect to site-specific conditions.

Cost screening consists of developing order-of-magnitude cost estimates for each corrective measures alternative based on similar sets of assumptions. Costs have been developed by analyzing data available from screening and implementing remedial and corrective measures alternatives at similar sites. Unit and total costs presented in the cost evaluations are present worth values structured to account for contaminated materials handling, adverse site conditions, administrative and engineering costs, and contingencies. Total costs were derived by applying estimated unit costs to assumed volumes of contaminated solid media. Present worth value for operation and maintenance costs were determined for a 30-year project life at a 5% discount value.

A screening summary is presented after evaluating each alternative to identify alternatives retained for further consideration (detailed evaluation/analysis) and to offer a rationale for excluding those alternatives that will not be considered further.

6.2.1 Alternative 1 - No Action

The NCP requires the consideration of a no action alternative as a basis for consideration of other alternatives. The no action alternative means that no actual corrective measures activities will occur at the site to control contaminant migration or to reduce toxicity or volume. The site would persist as is, with the Old Landfill only partially capped, the Clark Tailings cap partially eroding, and on-site groundwater contamination unaddressed.

Effectiveness - Protection of human health and the environment would not be achieved to the extent required by the regulations under the no action alternative. Prevention of direct human contact to wastes would not likely be achieved. The potential for solid media contaminant sources present at the site to contribute to surface water contamination would exist. Also, there are no controls preventing development of the affected aquifer, although development is not likely. Development of the aquifer for potable water may result in the exposure to humans of the groundwater CoCs via ingestion. Toxicity, mobility, and volume of contaminants would not be reduced under the no action alternative. Also, this alternative is not effective at satisfying state requirements for landfill closure, as required by the landfill's operating license issued by MDEQ.

Implementability - Technical and administrative feasibility evaluation criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary - This alternative has been retained as a comparison to other alternatives as suggested by the NCP.

6.2.2 Alternative 2 - Institutional Controls

The institutional control alternative includes erecting fences to restrict access to site, land use restrictions to control land development on or near the affected areas, and groundwater use restrictions to control the development and use of the affected aquifer in an unsafe manner.

New fence would be constructed by BSB around the perimeter of the site to restrict access. In addition, deed restrictions would be instituted that would not allow for the development of the site in a manner that may lead to increased exposure to the waste materials. The landfill site is currently owned by BSB. The adjacent Clark Tailings are owned by Inland Properties. BSB and Inland Properties are currently negotiating the transfer of the Clark Tailings property to BSB. The land transfer is scheduled to be completed by early 1997. Under this transfer, the deeds would include restrictive covenants as necessary.

A Groundwater Control Area (GWCA) would be established through the Butte-Silver Bow Water Quality District and the DNRC, in accordance with the Section 85-2-507 of the Montana Code Annotated (MCA). To establish GWCA, the State or Local Health Department would petition the DNRC. The boundaries of the controlled use zone would be established based on the current extent of groundwater contamination and the area within which large groundwater extraction rates may influence the contaminant plume. Within the GWCA, contaminated groundwater could not be used as a potable water supply. Also, development of the aquifer for industrial use near the site would not be allowed, since large groundwater extraction rates near the site may create a regional cone of depression, causing the contaminants to migrate. As discussed in Section 5, groundwater contamination has not caused the exceedence of GWPSs in wells downgradient from the site, and there are no known potable water supply wells

downgradient of the site. Monitoring would be conducted to track the extent and fate of groundwater contamination.

Effectiveness - This alternative will not satisfy regulations pertaining to landfill closure. It will minimize threats to human health by restricting access to the site and preventing the use of the affected aquifer as a potable water supply. Also, it would minimize exposure by direct contact with the source materials (Clark Tailings and municipal solid waste) by restricting access to the site. However, the potential for migration of groundwater CoCs would remain.

Implementability - Access restrictions to the site (fencing) are technically and administratively feasible and implementable. Access restrictions would contradict the community's plans for developing the site as a recreational facility, however. Deed restrictions are also easily implementable, particularly once the Clark Tailings property is transferred to BSB. Establishment of the controlled groundwater use area is implementable.

Cost Screening - Costs associated with institutional controls, shown on Table 6-4, would be relatively low as compared to other corrective measures. Capital costs are estimated at $158,510, with operation and maintenance (O&M) costs estimated at $23,100 annually. The total present worth, based on a 30-year life, is $514,000.

Screening Summary - Institutional controls will not be considered further as a stand-alone remedial alternative, but may be used in conjunction with other selected treatment alternatives.

6.2.3 Alternative 3 - Native Materials Capping

This alternative would include the installation of a cap comprised of native materials. The cap would be designed to satisfy landfill closure requirements. The Clark Tailings portion of the cap would be designed to support native vegetation. Typical cap cross-sections are shown on Figure 6-1 and are described below.

For the landfill, the cap under this alternative would consist of:

- installation of a minimum 24 inches cap with a maximum permeability of 1×10^{-3} cm/sec for areas which stopped receiving waste after October 9, 1991;
- installation of an infiltration barrier layer, consisting of a minimum 18-inch cap with a maximum permeability of 1×10^{-5} cm/sec, overlain by a minimum 6-inch earthen material layer capable of sustaining native plant growth and protecting from freeze/thaw damage, for those areas which received waste after October 9, 1991;
- revegetation of the cap to minimize erosion; and

- run-on and run-off control to prevent erosion and minimize infiltration.

The permitted landfill covers approximately 62 acres. Of this, 55 acres have been graded and capped in accordance with the guidelines stated above. Of the remaining 7 acres, approximately 3 acres will require the pre-October 9, 1991 cap and 4 acres will require the post-October 9, 1991 cap. In areas requiring the pre-October 9, 1991 cap, an average of approximately 6 inches of soil is in place (based on an existing cover investigation performed by SRM in 1992). Therefore, and additional 18 inches of soil meeting the permeability specification are required. The entire area may require nutrient addition and seeding to establish a vegetative cover. A site plan showing the areas already capped and those requiring additional capping are shown on Figure 2-2.

On the Clark Tailings, the cap would consist of a minimum 18-inch native soil cap. This cap would be graded and revegetated to minimize erosion. The Clark Tailings currently cover approximately 60 acres. This area was capped in the mid-1980's and revegetated. However, a full 18-inch cap was not installed or has eroded away. As a result, there are localized areas where gullies and rills have been observed. Also, there are portions of the site which have sparse vegetation. It is estimated that the average cap depth in place on the Clark Tailings is approximately 6 inches. Therefore, to complete this alternative, this portion of the site requires an additional 12 inches of native soil (on the average) and revegetation (including potential soil amendments, seeding, and mulching). Prior to installing the cap, the materials from the LAO Operable Unit of the Butte Area NPL site will be imported. These materials will be placed, graded, and compacted in a manner conducive to the development of the site as a recreational complex. Also, the Clark Tailings will be consolidated as much as practicable before the installation of the cap. Surficial and thin deposits of tailings from the periphery of the Clark Tailings will be excavated and placed within the main portion of the Clark Tailings. This will reduce the area to be capped. Also, by reducing the areal extent of the Clark Tailings, the amount of leachate generated by the Clark Tailings is reduced. The extent of the existing Clark Tailings cap is shown of Figure 2-2; consolidation of the Clark Tailings is expected to reduce this area by 10 to 20 percent.

Run-on and run-off control measures would also be designed and implemented at the site to minimize erosion and infiltration. The closed landfill will be graded to promote run-off. The landfill would be graded so that the average slope over the gradually sloped portions of the landfill will be approximately 5%; in this way, the potential for ponding due to differential settlement is minimized. The maximum slope will be (33%) 3:1 to prevent erosion and ensure slope stability. The steepness of slopes will be minimized to the extent possible to minimize erosion potential and difficulties establishing vegetative cover; the target for side slopes for the Old Landfill and the Clark Tailings will be 4 to 5:1.

To implement this alternative, the entire site would be graded to support a recreation-facility type final use. Additional work would be required to develop the site into a recreational facility, but the intent would be to make the site amenable to this type of development. To this end, the area of the landfill that is already graded and capped (approximately 55 acres) would not be disturbed except to complete revegetation efforts. The remainder of the landfill (7 acres) would be graded

and capped. Finish grades would be amenable to the use of the site as a golf course driving range or similar type of recreation. The conceptual final site grading plan after implementation of this alternative, after the LAO materials have been imported, is shown on Figure 6-2. These grading plans would be refined during detailed design of the site closure.

Soils for capping would come from borrow sources near the site. A geotechnical investigation (Braun Intertec, 1993) of borrow soils from BSB-owned property southwest of the site showed that the sandy lean clay soils present would meet the permeability specification of 1×10^{-5} cm/sec, if compacted to 90% of their standard Proctor density. The sandy lean clay soils (those determined to satisfy the permeability specification) would be selectively excavated from the borrow area for use in the landfill cap (on those portions of the landfill requiring the 1×10^{-5} cm/sec soil cap). This cap would be installed until there is a minimum of 18 inches of soil meeting the permeability requirement. Above the low permeability layer, a minimum of 6 inches of soil would be installed to provide a vegetative growth layer. This soil would most likely come from the borrow area southwest of the landfill. Areas which did not receive waste after October 9, 1991, will be graded and then soils from the borrow area meeting the 1×10^{-3} cm/sec permeability standard will be placed to a minimum depth of 24 inches. Additional soils that satisfy the 1×10^{-5} cm/sec standard are available from the Hollow borrow pit north of the site. A geotechnical investigation of these soils was conducted, including the construction of a test pad to test in situ permeability. The investigation showed that these materials easily satisfy the 1×10^{-5} cm/sec standard; based on the in situ permeability testing, these clayey sands can achieve an in situ permeability of 5×10^{-7} cm/sec. A report of the geotechnical characteristics and the in situ permeability testing of these soils is included in the *Clark Tailings Disposal Area Cap Construction Quality Assurance Plan* (Pioneer, 1996a).

A total of 7 acres of the landfill require additional capping. Of this, 4 acres require a cap meeting the 1×10^{-5} cm/sec permeability specification, and 3 acres require the 24 inches of 1×10^{-3} cm/sec soil. In areas requiring the 1×10^{-3} cm/sec soil, an average of approximately 6 inches of soil is in place. Therefore, an average of 18 inches, or a total of 12,100 cy, of soil will be required for this cap. On areas requiring the 1×10^{-5} cm/sec permeability specification soil, 18 inches of this soil would be imported and placed. Thus, a total of 10,000 cy of this soil will be required. On top of this, 3,200 cy of soil would be installed to make up the 6-inch vegetative layer. The post-October 9, 1991 portion of the cap would be installed in accordance with the *Construction Quality Assurance Plan for the Old Butte-Silver Bow Landfill Final Cover Installation* (Pioneer, 1996b).

At the Clark Tailings portion of the site, materials from the LAO would be imported, placed, and compacted. The fill would be placed and graded to support the site's use as a recreational facility including athletic fields. Surficial deposits of tailings would be excavated and consolidated within the main portion of the Clark Tailings. Before placing the cap, existing cap materials would be removed and stockpiled to the extent feasible. After grading the site to promote run-off and for use as a recreational facility, the stockpiled material would be reinstalled as cap. Additional capping materials would then be imported from the borrow area southwest of the landfill, the Hollow pit, ARCO-owned cover soil sources west of LAO, or clean cover soil from

the west end of LAO. In total, a minimum of 18 inches of native soil material will be placed over the tailings. Immediately below the cover soil, a three-inch lift of coarse rock will be installed as a capillary break/drainage layer. This layer will promote subsurface drainage and will prevent upward capillary migration of water from the tailings.

After capping materials are placed, most of the site will be prepared to establish a vegetative cover. This may include organic material and fertilizer addition, mulching, and seeding. Those portions of the site not prepared for vegetation may include areas planned for parking lots, roads, or structures as part of the recreational facility.

Samples of the probable seed bed layer soils to be used in the caps of both the landfill and the Clark Tailings were analyzed for nutrient and organic matter content. Analysis showed an average organic matter content of 1.4% in the soils. To increase organic matter content, organic matter, in the form of compost and/or sewage sludge, may be added to the soils. Stabilized sewage sludge from the Butte Metro Sewage Treatment Plant would be applied by BSB personnel using their sludge application equipment.

Fertilizer application will be based on the nutrient requirements of the amended soil. Nutrient content analysis of the probable cover soils showed that there is adequate phosphorus and potassium content in the soils to support native grasses, but additional nitrogen will be necessary. Based on the available data, up to 150 lbs/acre of ammonium nitrate fertilizer may be required. However, some nitrogen would be added if organic matter is added; therefore, less than 150 lbs/acre may be required.

Straw mulch will be used on the majority of the site; it will be crimped into the ground with standard agricultural equipment. The area will be drill seeded with a mixture of annuals (to establish a vegetative cover) and native perennial grasses, or other grasses and forbs (and possibly shallow-rooting shrubs and trees in selected areas) conducive to development of a recreational complex. If capping is completed in the summer, the area will be amended and mulched at that time. Fertilization and seeding will be postponed until conditions are appropriate for grass seeding (in the fall or spring).

In addition to grading and capping the site, structures would be installed to handle surface water run-on and run-off. Diversions would be constructed at the south end of the facility to route run-on around the perimeter and discharge it to the Grove Creek Sedimentation Pond or the Timber Butte Sedimentation Basin, as shown on Figure 6-2. Local topography makes it infeasible to route all local drainage around the site. Therefore, one drainage will be routed over a portion of the site in a ditch designed to handle the 25-year storm event. Other ditches and diversions will be used to route run-on and run-off to the Grove Creek Sedimentation Pond or the Timber Butte Sedimentation Basin. Together, these structures will remove the majority of any solids that may be eroded from the site before discharging the run-on/run-off water to Grove Gulch. These structures would be designed to accommodate the peak flow from the 25-year run-off storm event.

Long-term groundwater monitoring at the site would also be implemented. Groundwater sampling would be conducted in accordance with the corrective measures groundwater monitoring plan, described in Section 10.

Effectiveness - This action would be effective in that it will prevent direct exposure of tailings and landfill wastes to humans. It will decrease the mobility of waste materials present at the site. It will minimize erosion and potential impacts to surface waters. Site grading and installation of the soil caps described will lessen the amount of water infiltration and ensuing leachate generation. Based on HELP modeling results, infiltration and leachate generation rates from the landfill and the Clark Tailings will be decreased by over 50%. Modeling results are included in Appendix D. The actual decrease in leachate generation rates will most likely be greater than that predicted by the model. Grading of the site will remove small depressions that currently exist but are difficult to quantify. This will result in an increased run-off fraction and a decrease in infiltration. The evapotranspiration will be increased significantly by installing a better quality of seed bed layer and establishing vegetation. This will also decrease erosion. Also, implementing run-on controls and controls to prevent ponding and infiltration upgradient of the wastes will further decrease leachate generation rates.

This alternative would satisfy minimum regulatory standards for closure of the landfill. On the post-October 9, 1991 portion of the landfill, the 18 inches of low permeability soil would satisfy the requirements for the infiltration barrier layer and the 6 inches of topsoil soil would satisfy the requirements for the erosion control layer. By compacting the infiltration barrier layer, root penetration into the layer will be prevented. Also, frost effects are expected to be minimal on the infiltration barrier layer proposed in this alternative. Frost effects are greatest when moisture is present in the infiltration barrier layer soils. Because of the site's arid climate; the presence of a evapotranspirative layer above the infiltration barrier layer; and the distance from the barrier layer from a water source (i.e., groundwater), the infiltration barrier layer is not anticipated to have enough moisture available to cause significant frost damage. Furthermore, the portion of the landfill which requires this type of cap (per the regulatory standards) constitutes only 6.5% of the entire landfill. The cover on the balance of the landfill will also satisfy regulatory requirements (for areas that stopped receiving waste before October 9, 1991). However, when the LAO materials are imported, this portion of the site may be considered a waste management unit that received waste after October 9, 1991. Therefore, the native soils cap included in this alternative will not meet the capping requirements at ARM 17.50.530.

This alternative would reduce the amount of infiltration through the wastes, and leachate generation, as discussed above. This, in turn, would reduce the flux of contaminants from the waste sources to the groundwater via the aqueous phase. Therefore, this alternative may be effective at achieving GWPSs, since existing groundwater contamination may be adequately addressed through attenuation and natural degradation. However, if landfill gas is the source of VOCs in groundwater (as the data suggests), this alternative would

not be effective, by itself, at addressing the VOCs in groundwater. The alternative would be expected to reduce the flux of inorganic contaminants to groundwater from the Clark Tailings portion of the site by a percentage comparable to the reduction in infiltration/leachate generation. This will be effective at reducing the flux of inorganic contaminants to groundwater and may achieve GWPSs.

Implementability - This alternative is technically feasible. The capping and surface water controls required are proven technologies. Labor and materials necessary to construct the alternative as specified are available locally. Borrow soils are available from BSB property southwest of the site or the Hollow pit north of the site. These soils, when compacted, will meet the permeability specifications for the landfill cap (Braun, 1993). Seed bed layer soils are also available on nearby BSB property. The alternative could be implemented by BSB directly or it could be contracted. The alternative is also administratively feasible. The ability of the alternative to minimize the spread of groundwater contamination must be quantified to determine if other actions, in addition to this, must be implemented to satisfy administrative requirements. Permitting requirements would be minimal.

Cost Screening - The total present worth cost for this alternative, based on a 30-year life, has been estimated at $1,438,000. Estimated costs are shown on Table 6-5. The total cost includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary - This alternative is considered effective at satisfying regulatory requirements for landfill closure and may be effective at addressing inorganic groundwater contamination. It is required, at a minimum, to satisfy MDEQ regulations for landfill closure. However, the alternative is not expected to be effective at controlling VOC groundwater contamination that is caused by landfill gas. Therefore, this alternative independently will not be retained for further consideration. However, it is retained in combination with other measures as explained below.

6.2.4 Alternative 4 - Native Materials Capping with Institutional Controls

This alternative includes implementing institutional controls to prevent exposure in addition to installing a native materials cap as described in Section 6.2.3. Institutional controls may include:

- deed restrictions to prevent the development of the site in a manner inconsistent with the BSB Land Use Master Plan and ARM 17.50.530;
- establishing a GWCA via the BSB Health Department and the DNRC;
- implementing a groundwater monitoring program to ensure that downgradient aquifer users are not exposed to CoCs; and

- monitoring.

The Clark Tailings portion of the site is currently owned by Inland Properties. BSB is currently in the process of acquiring the Clark Tailings property from Inland Properties so that BSB will be the sole owner of the entire site. The area is currently zoned for recreational uses; residential development is precluded. Deed restrictions would also be implemented to prevent the development of the site in a manner that may not be protective of human health and the environment.

Institutional controls would be effective in preventing exposure of contaminants to humans by restricting development of the affected aquifer via a GWCA. The aquifer could not be used as a potable water supply. Also, the aquifer could not be used in the vicinity of the site for industrial or other large-scale uses that may create a regional cone of depression that may lead to contaminant migration.

A post-closure groundwater monitoring program would be implemented (as required under solid waste regulations at ARM 17.50.721). This monitoring program may include downgradient wells to ensure that the contaminant plume is not impacting any downgradient potable water supply wells.

Effectiveness - This alternative may be effective in addressing groundwater contamination in the same manner as the native soil cap described in Section 6.2.3. It will satisfy regulatory requirements for closure of the landfill, but may not meet cap requirements for the Clark Tailings after the LAO materials are imported and placed. By implementing institutional controls, the possibility of exposure to humans is further reduced. Deed and/or zoning restrictions would prevent development of the site in a manner which would be inconsistent with BSB's Land Use Master Plan and ARM 17.50.530. By implementing a controlled groundwater use area, exposure to contaminants via ingestion of contaminated groundwater will be prevented. Post-closure monitoring of the groundwater will determine if the alternative is effective in addressing existing groundwater contamination.

Implementability - The capping portion of this alternative is technically and administratively feasible. Institutional controls are also feasible and implementable. Establishing the controlled groundwater use area is implementable; it would require a petition by the State or BSB Health Department to the DNRC. The BSB Health Department has agreed that a GWCA is appropriate for this area.

Cost Screening - The total present worth cost for this alternative has been estimated at $1,575,000. The majority of these costs are for installation of the soils cap. Estimated costs are shown on Table 6-6. The total cost includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary - This alternative would protect human health by minimizing exposure to humans. It is considered to be more effective at preventing exposure than the native soils

cap by itself (Alternative 3). While it may not directly control VOC groundwater contamination caused by landfill gas (as described for Alternative 3), it would prevent exposure to these contaminants via control of the use and development of local groundwater. Therefore, this alternative is retained for detailed analysis.

6.2.5 Alternative 5 - Low Permeability Capping with Institutional Controls

This alternative consists of importing LAO materials to the Clark Tailings, capping of the landfill and Clark Tailings, hydraulic (run-on/run-off) controls, and institutional controls. The alternative is very similar to Alternative 4, except that a less permeable cap (exceeding capping requirements at ARM 17.50.530 for areas that received waste after October 9, 1991) will be installed on the Clark Tailings portion of the site.

The Old Landfill will be capped with native soils satisfying solid waste regulations in the same manner described in Alternative 3. The Clark Tailings will be capped with a multi-layer cap consisting of, from bottom to top: 18-inches of low permeability native soil (in the range of 1 x 10^{-5} cm/sec to 1 x 10^{-7} cm/sec); a geotextile separation/filter fabric; three inches of a capillary break/drainage material; and 18-inches of cover soil/vegetative growth media. A typical cross section of the Clark Tailings cap under this alternative is shown on Figure 6-3. Based on covering 52 acres (after consolidation of the Clark Tailings), approximately 126,000 cy of the low permeability materials will be required. Native silt or clay materials from the LAO excavation or native clayey sands from a pit immediately north of the site will be used for the low permeability infiltration barrier layer.

Areas that will be paved, such as parking areas and roads, as part of the planned recreational complex at the site may be capped in a different manner. These areas (shown of Figure 9-3) may be capped with a native soil cover overlaid by base coarse (which will serve as capillary break and drainage layer and will improve strength to the overlying asphalt) and flexible asphalt pavement. The asphalt pavement will act as the infiltration barrier layer. These areas will be graded to promote run-off. The pavement will be designed to minimize cracking potential, and asphalt will be strictly maintained to fix any cracks or holes. This is similar to the portions of the cap installed at the Old Works/East Anaconda Development Area Operable Unit near Anaconda, Montana.

A lower permeability cap is not planned over the entire landfill based on the premise, discussed in Section 5.4 (Conceptual Site Model), that landfill gas is the most likely source of VOC contamination, not leachate from the landfill. Additionally, water balance modeling shows that the native soils cap offers a comparable level of effectiveness (because of evapotranspiration) with respect to infiltration. In this case, installing a lower permeability cap over the landfill would not be any more effective at achieving GWPSs for VOCs. Installing the cap over the Clark Tailings would reduce leachate generation rates from baseline conditions, and, therefore, the flux of contaminants to the groundwater. In this manner, concentrations of inorganics in groundwater will be reduced. Also, the low permeability cap in this alternative will satisfy solid waste regulations for areas that receive waste after October 9, 1991, which will be the case when the LAO materials are placed at the site.

Materials from the LAO Operable Unit would be imported to the Clark Tailings site prior to closure. These materials would be placed and compacted in a manner conducive to future development as a recreational complex. The approximate final grading with the LAO materials imported is shown on Figure 6-2.

Prior to capping and after placing the LAO materials, the Clark Tailings site would be graded to prevent run-on and promote run-off. These storm water controls would include measures to prevent uncontrolled ponding and infiltration of water upgradient of the wastes. As part of this effort, an engineered storm water pond lined with geosynthetic clay liner (GCL) will be installed south of the Clark Tailings. Also, the Timber Butte Sedimentation Basin will be GCL-lined to prevent infiltration through tailings in this area. Run-off currently collects in this area and is allowed to infiltrate through tailings to the underlying aquifer. The grading plan would be intended to prepare the site for use as a recreational complex after closure. Grading would include consolidation of some surficial tailings with the rest of the tailings to minimize the surface area covered by tailings, and, therefore, minimize the potential for leachate generation and migration of contaminants to groundwater.

The low permeability soil for the Clark Tailings cap would most likely be clayey sands from the Hollow borrow pit north of the site. In situ testing of test pads constructed from these soils showed their permeability to range from 1.6×10^{-7} cm/sec to 5.2×10^{-7} cm/sec, when compacted to an average of 96.7% of their standard Proctor density (Pioneer, 1996b). Alternatively, native silts and clays from the LAO Operable Unit, which will be removed as part of that remedial action, may be used for the infiltration barrier layer. These materials would be used if they do not leach unacceptable levels of metals and are approved by MDEQ. The in situ permeability of these materials ranged from 1.3×10^{-7} cm/sec to 6.8×10^{-7} cm/sec, when compacted to an average of 96.1% of the standard Proctor density (Pioneer, 1996b). Investigations of these sources of materials show that there is an adequate volume of these materials available to provide the 126,000 cy necessary. Capillary break/drainage layer materials would consist of a gravel (ranging primarily from 3-inch to 3/4-inch particle size, with less than 10% fines) available at a pit near Crackerville, Montana (approximately 10 miles west of Butte). Cover soil/growth media will most likely come from borrow sources southwest of the landfill; the Hollow pit north of the site; ARCO-owned sources west of the LAO Operable Unit (approximately 2.5 miles northwest of the Clark Tailings), or clean soils from the west end of LAO.

In addition to the low permeability layer, the presence of the capillary break will also mitigate infiltration (and the potential for leachate production) by increasing evapotranspiration (Stormont, et al, 1995) and will minimize upward wicking (caused by capillary rise) of water from the tailings to the vegetative root zone.

In addition to capping and hydraulic controls, institutional controls will be implemented at the site. These controls would include deed restrictions to prevent the development of the site in a manner inconsistent with the wastes present at the site and the BSB Land Use Master Plan; implementing a GWCA through the BSB Water Quality District and DNRC that would restrict the use of the affected aquifer; and a post-closure groundwater monitoring program. These institutional controls would be effective in preventing exposure of contaminants to humans.

Effectiveness - This alternative will be effective at satisfying closure requirements and at controlling the sources of inorganic groundwater contamination. Installing the low permeability cap over the Clark Tailings will decrease leachate production by nearly 60% over existing conditions based on HELP modeling results (Appendix D). Much of the leachate that is produced is from free water currently within the Clark Tailings draining from the materials, or, in other words, the drying of the tailings over time. (This would occur no matter how impermeable of a cap was installed.) This will be minimized by dewatering the LAO materials prior to their placement at the Clark Tailings. Furthermore, the cap as described will satisfy regulatory requirements for landfill closure. However, the alternative may not adequately address VOC contamination that may be caused by landfill gas. The landfill gas may continue to contact groundwater, transferring the VOCs from the gaseous phase to the aqueous phase, and groundwater contamination in exceedence of GWPSs may persist.

Implementability - This alternative is administratively and technically feasible and implementable. It satisfies regulatory requirements for waste management unit closure. Capping with low permeability materials is a common construction practice; the materials, equipment, and expertise required locally available. In situ testing of the locally available infiltration barrier materials shows that they are capable of providing a permeability of less than 1×10^{-6} cm/sec.

Cost Screening - The total present worth cost for this alternative has been estimated at $2,989,000. Estimated costs are shown on Table 6-7. The total cost includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary - This alternative would protect human health by minimizing exposure to humans. It will satisfy regulatory requirements for closure. The low permeability cap over the Clark Tailings will satisfy closure of post-1991 filled areas, which will be necessary when the LAO materials are placed at the site. While this alternative may not directly control VOC groundwater contamination caused by landfill gas, it would prevent exposure to these contaminants via control of the use and development of local groundwater. Therefore, this alternative is retained for detailed analysis.

6.2.6 Alternative 6 - Multimedia Capping with Institutional Controls

In this alternative, a multimedia cap would be placed over the Old Landfill and Clark Tailings to minimize infiltration of surface water through the wastes and the ensuing production of leachate. This alternative is very similar to the native soil cap alternative (Alternative 4) except that a multimedia cap would be installed instead of the native soil cap described in Section 6.2.3. The cap would consist of a vegetated soil/erosion control layer, a subsurface drainage layer, a flexible membrane liner, and a native clay or geosynthetic clay liner (GCL). A typical cross-section of the cap is shown on Figure 6-4.

Prior to installation of the cap, LAO materials would be imported and placed on the Clark Tailings portion of the site as described previously. Surficial tailings from the periphery of the Clark Tailings would be consolidated with the rest of the tailings.

For this preliminary evaluation, it is assumed that the multimedia cap would be placed over the entire site (estimated at 114 acres after consolidation of the Clark Tailings). Run-on/run-off controls to manage surface water would also be installed.

In addition to installing a multimedia cap, institutional controls would be implemented to minimize the potential of exposure. These controls would be the same as those explained for the native soils cap with institutional controls alternative (Alternative 4).

To implement this alternative, the site would first be graded in anticipation of it's development as a recreational facility. Target slopes on the landfill (which is more susceptible to differential settlement) would be a minimum of 2% on top slopes, with an average of at least 4%, and a maximum of 33% (3H:1V) on side slopes. Topsoil and vegetation would be cleared and stockpiled. A minimum of 12 inches of the leveling materials would be placed over the wastes. Existing cover soil would be used for this purpose to the extent possible. The multimedia cap would then be installed. The cover soil would be amended as necessary to support a vegetative cover (with lime, sewage sludge, and/or fertilizer), seeded, and mulched. Erosion control mats may be used in surface water diversions where the calculated flow velocities are likely to cause erosion without Best Management Practices (BMPs). Riprap may also be used for energy dissipation on very high velocity channel reaches. After installation of these measures, the site would look just as it would after implementation of Alternative 3, shown on Figure 6-2.

Effectiveness - This alternative would be effective at preventing direct exposure of tailings and landfill wastes to humans. Also, it will minimize erosion and potential impacts to surface waters. It would be no more effective in these areas as Alternative 3. This alternative may be more effective at minimizing the infiltration of surface water and the potential production of leachate. According to HELP model results, this alternative would reduce leachate generation significantly (HELP results are included in Appendix D). This type of cap would satisfy regulatory requirements at ARM 17.50.530.

By minimizing the amount of surface water infiltration, this alternative may minimize further degradation of groundwater, particularly by inorganics. Natural phenomena, such as attenuation and degradation, may adequately address existing groundwater contamination, preventing it's migration and lowering it to levels meeting GWPSs with time. However, this alternative will not be effective at addressing VOC contamination caused by landfill gas. While institutional controls will be effective at preventing human exposure to these contaminants, VOCs in groundwater may persist.

Implementability - The capping portion of this alternative is technically feasible and implementable. Institutional controls are also feasible and implementable. Establishment

of the controlled groundwater use area is implementable, but may require the agreement of affected aquifer users (who hold water rights) and public acceptance.

Cost Screening - The present worth for the multimedia cap portion of this alternative is estimated at $8,451,000 (Table 6-8); the majority of these costs are associated with the cost of the multimedia cap. The total present worth cost estimate includes capital costs and the present worth value of 30 years of annual maintenance and groundwater monitoring.

Screening Summary - This alternative offers a slight reduction in the generation of leachate from surface water infiltration than the native soils cap, but at a much higher cost. Costs of this magnitude would require BSB to raise current landfill user rates. Also, the data indicate that the source of VOC groundwater contamination is landfill gas, not leachate. Therefore, this alternative is no more effective at addressing these CoCs as Alternative 4, but at a much higher cost. Therefore, this alternative will not be retained for further consideration.

6.2.7 Alternative 7 - Vertical Groundwater Barriers with Capping and Institutional Controls

In this alternative, vertical groundwater barriers would be installed to prevent the flow of groundwater through the site. Vertical groundwater barriers could consist of a slurry wall, sheet pilings, or cement- or clay-based grout curtains. The most likely process option, considering local subsurface strata, is the slurry wall. The wall would most likely be installed at the upgradient perimeter of the site.

A barrier at the upgradient site perimeter would be intended to prevent the flow of uncontaminated groundwater through the wastes present at the site. The barrier would extend from the surface to the soil/bedrock interface. In addition to the slurry wall, hydrodynamic control would be necessary to prevent saturation of soils upgradient from the site. Hydrodynamic controls would consist of a series of extraction wells which would remove water retained behind the slurry wall. The clean water removed would be reinjected downgradient of the site, discharged to surface water, or used for irrigation.

In addition to the slurry wall, a cap, as described in Alternatives 3, 5, or 6 would be installed over the landfill and Clark Tailings to control infiltration and ensuing leachate production. Prior to installation of the cap, LAO materials would be imported and placed on the Clark Tailings portion of the site as described previously. Surficial tailings from the periphery of the Clark Tailings would be consolidated with the rest of the tailings. Also, surface water management controls would be implemented; long-term groundwater monitoring would be conducted; and institutional controls for groundwater use in the vicinity of the site would be implemented (as described in Alternative 4).

Effectiveness - The installation of a cap would be effective at preventing direct exposure and reducing leachate generation due to surface water infiltration. However, the installation of an upgradient vertical groundwater barrier would not be effective. If a competent

barrier wall/bedrock contact is not achieved, the barrier will not provide any additional effectiveness. The underlying bedrock is fractured and weathered, and the likelihood of achieving a competent seal is uncertain. Groundwater removal would be required also. Groundwater removal by itself, properly designed, would be just as effective at preventing downgradient migration of contaminants. Also, this alternative would likely be effective at controlling VOC groundwater contamination caused by landfill gas. Landfill gas would continue to migrate and contact groundwater, transferring the VOCs to the aqueous phase.

Implementability - Technical feasibility of this alternative is uncertain because of difficulties is defining the subsurface to the extent necessary to ensure that a seal is achieved between the slurry wall and the underlying bedrock. If this seal is not achieved, the continued potential for groundwater to enter the waste areas and mobilize contaminants will continue to exist. This alternative is administratively feasible.

Cost Screening - A 40-ft deep, 4-ft thick bentonite-based slurry wall was estimated at $310 per foot (EPA, 1987). The overall cost estimate for implementing this alternative is $3,951,000, as shown on Table 6-9. The majority of theses costs are associated with the landfill portion of the site; these costs would require BSB to raise current landfill user rates. This cost is based on installing the native soils cap described in Alternative 3, which may not satisfy regulatory requirements for closure of the Clark Tailings portion of the facility. If a less permeable cap is installed, such as that described in Alternative 5, costs would increase by approximately $1.5 million.

Screening Summary - Since the upgradient slurry wall would not be any more effective than other alternatives and it's effectiveness and implementability are uncertain, this alternative will not be considered further.

6.2.8 Alternative 8 - Landfill Gas Removal with Capping and Institutional Controls

In this alternative, soil vapors and/or landfill gas would be extracted from the landfill. This alternative would also include the installation of a low permeability cap and institutional controls, as explained in Alternative 5. Prior to installation of the cap, LAO materials would be imported and placed on the Clark Tailings portion of the site as described previously. Surficial tailings from the periphery of the Clark Tailings would be consolidated with the rest of the tailings.

Landfill gas is being generated within the Old Landfill by the anaerobic decomposition of municipal solid wastes. Landfill gas may be produced for many years after the landfill is closed. Landfill gas is comprised of approximately 50% methane (CH_4) and 50% carbon dioxide (CO_2) (SWANA, 1989). However, landfill gas typically contains many trace constituents, including those organic compounds identified as CoCs in groundwater at the site (McBean, et al, 1995, pg.408, SWANA, 1989). AP-42 landfill gas VOC emission factors (EPA, 1995) for the organic CoCs at the site include:

Constituent	Gas Concentration (ppmv)
1,1-Dichloroethane	2.07
Tetrachloroethene	3.44
Trichloroethene	2.08

SWANA (1989) reported the following average VOC concentrations in landfill gas emissions:

Constituent	Gas Concentration (ppmv)
1,1-Dichloroethane	4.24
Tetrachloroethene	8.29
Trichloroethene	3.88
1,2-Dichloroethene	6.90
Vinyl chloride	7.72

Also, as explained in Section 5, landfill gases at the site contain detectable concentrations of the VOC contaminants present in the groundwater at the site. Also, VOC contamination has appeared to move across the groundwater gradient (e.g., from well BSB-A2 toward BSB-A6), not downgradient as it would if leachate were the source. By removing landfill gas, the source of groundwater VOC contamination would be removed.

Landfill gas could be removed either passively or actively. For the purposes of this assessment, it is assumed that a passive gas removal system would be installed, since an active system is not required under solid waste or air quality regulations. EPA's NSPS for landfills become effective when the design capacity of the landfill is greater than 2.8 million tons or 3.3 million cy. A passive system venting landfill gas to the atmosphere may require permitting (under MDEQ regulations) if it has the potential to emit over 25 tons per year of non-methanogenic organic compounds (NMOCs) to ensure that there are no significant impacts to air quality. However, available data indicate that this will not be the case. An analysis of potential NMOC discharges, based on EPA's Landfill Air Emissions Estimation Model (EPA, 1996), is included in Appendix E. This conservative analysis shows that the landfill is expected to emit no more than 7.7 metric tons (or 8.5 tons) of NMOCs in its peak year of gas production.

Passive removal involves spaced vents around the landfill to route the gas to the vents. Typically, high permeability gas collection trenches or perforated pipe are installed. These trenches lead to vents through the landfill cap or the cover soils. A typical landfill gas vent is shown on Figure 6-5.

An active landfill gas extraction system could also be installed, although the available data do not suggest (and regulations do not require) that it would be necessary. Active landfill gas extraction involves the installation of gas extraction wells. A vacuum is induced on the wells, and landfill gases are drawn through the refuse to the wells. McBean (1995) reported effective landfill gas radii of influence in refuse from 150 to 500 feet. The radius of influence will vary with the

amount of vacuum placed on the extraction well; the gas flow; and the permeability of the refuse (or other media from which gas is being removed) and the permeability of the overlying soils. Landfill gas from the extraction wells is usually routed, via a collection header network, to a common point. By focusing the landfill gas emissions to a point source with a landfill gas extraction system, the potential for impacts to human health and the environment may be increased. Therefore, some form of landfill gas treatment is usually necessary. This can include storage (for later processing and sale or energy recovery); burning for on-site energy recovery; or, most commonly, flaring the gas. Also, landfill gas condensate must be collected if active landfill gas extraction is employed. The condensate must be treated on-site before discharge or disposed off-site, most likely via the publicly-owned treatment works (POTW).

A native soils cap (as described in Alternative 3) satisfying solid waste regulations would be installed over the landfill portion of the site to minimize infiltration and prevent direct contact. The Clark Tailings would be consolidated and the LAO materials would be imported and placed at the Clark Tailings. Over the Clark Tailings, a low permeability soils cap would be installed as described in Alternative 5. This cap would consist of native materials with a permeability less than that required under solid waste closure regulations at ARM 17.50.530. This cap will minimize infiltration and leachate production through the Clark Tailings in an effort to control inorganic contaminants that may be originating in the Clark Tailings. It will also satisfy solid waste regulations for areas that received waste after October 9, 1991, which will be the case at the Clark Tailings after the LAO materials are placed there. Grading and run-on/run-off controls will also be implemented to reduce infiltration, erosion, and migration of contaminants via the surface water pathway. In addition, institutional controls restricting land and groundwater use, as explained in Alternative 4, would be implemented as part of this alternative.

Effectiveness - This alternative is expected to be effective at mitigating groundwater contamination at the site and satisfying pertinent regulations. By venting landfill gas, the transfer of VOCs from the gaseous to the aqueous phase is reduced, mitigating further VOC contamination of groundwater. Installation of a the cap over the landfill will satisfy regulatory standards, prevent direct contact, and reduce the amount of infiltration through the landfill. The cap over the Clark Tailings will reduce infiltration through the mine wastes, primarily by increasing evapotranspiration and subsurface drainage, and mitigate inorganic contamination originating in the Clark Tailings. As described in Alternative 5, it will also satisfy regulatory requirements for closure of areas that receive waste after October 9, 1991.

Implementability - This alternative is technically feasible. Installation of passive landfill gas extraction systems is a conventional technology. Capping with low permeability materials as described is also a conventional technology, with the equipment, materials, and expertise available locally.

Cost Screening - The costs to implement this alternative as described are summarized in Table 6-10. These include the costs to install the gas venting system, the native soils cap over the

landfill, a low permeability soils cap over the Clark Tailings, and to implement institutional controls. The present worth of this alternative is estimated at $3,068,000.

Screening Summary - This alternative would be effective at addressing groundwater contamination at the site. Landfill gas venting will control the source of VOC groundwater contamination, since the data indicate that landfill gas is the probable source of groundwater contamination. (This technology has been selected as part of the preferred alternative at the BFI Landfill in Missoula, Montana.) The low permeability cap over the Clark Tailings, combined with run-on/run-off controls and institutional controls, would mitigate inorganic groundwater contamination. Therefore, this alternative will be retained for further analysis.

6.2.9 Alternative 9 - Groundwater Removal and Treatment with Capping and Institutional Controls

This alternative would involve the extraction of the contaminated groundwater plume, via interceptor trenches or wells, and ensuing treatment to remove the CoC. Treatment could be conducted either on-site in facilities constructed for this purpose, or off-site at the POTW. In addition to groundwater removal and treatment, a cap would be placed on the landfill and Clark Tailings. For the purposes of this assessment, the cap would be a native soils cap as described in Alternative 3. A less permeable cap could be installed, such as that described in Alternative 5 or Alternative 6. The cap would be installed after LAO materials are imported and placed at the site, as described previously.

Groundwater extraction would most likely employ extraction wells. Well spacing and extraction rates are based on the effective radius of influence of the wells, which varies with local conditions. Based on available data, it is estimated that groundwater would need to be extracted from the downgradient boundary of the site at approximately 100 gallons per minute (gpm) to prevent contaminants from travelling beyond the boundary. To remove the 100 gpm along the boundary, an estimated 11 extraction wells would be required. These assumptions would need to be checked with site-specific pumping tests during the design phase should this alternative be implemented.

Once the groundwater is extracted, it would be routed to a treatment facility. Many process options exist for treatment of the contaminated groundwater. Based on the CoCs identified for the site (Section 5), processes to treat both organic and inorganic contaminants may be required. Groundwater treatment process options are discussed below.

One option for off-site treatment would involve piping the contaminated groundwater to the POTW. However, the BSB POTW has strict industrial influent limitations for many of the metals present in the groundwater. Based on the groundwater quality data and the influent limitations, pretreatment of the groundwater to remove zinc (and possibly other metals) would be required. Also, any VOC present at concentrations greater than 100 μg/L will most likely require treatment to below 100 μg/L. Based on existing data, cis-1,2-dichloroethene would require

pretreatment. At the POTW, the water (after pretreatment) would be treated biologically via an activated sludge process. Remaining organic compounds would be volatilized and/or biologically degraded. Remaining metals would be sequestered to the solids fraction of the waste stream (the sewage sludge). The nearest sanitary sewer is along Montana Street, approximately 2,800 feet northeast along Beeftrail Road from the likely groundwater extraction well(s) location. A new sanitary sewer would be required to connect the site to the existing sanitary sewer. This treatment process would be effective at treating the contaminants; it would reduce the toxicity, mobility, and volume of the hazardous materials removed from the aquifer.

On-site treatment options for addressing inorganic CoCs (iron, zinc, cadmium, etc.) include precipitation, ion exchange, and membrane processes such as reverse osmosis. Biological processes could also be used effectively to fix heavy metals. These processes include constructed wetlands.

Precipitation may be effective at removing heavy metals from the aqueous phase, reducing volume and mobility. However, precipitation will generally leave some concentration of contaminants in solution, depending on it's solubility. For CoCs at this site, the solubility of hydroxide and sulfide precipitates is shown on Figure 6-6. Hydroxide solubilities are greater than the CALS and/or HHS for some CoCs (such as zinc). Therefore, a polishing treatment would most likely be required before direct discharge to Grove Creek or groundwater. Sulfides are generally less soluble; sulfide precipitation may be capable of attaining discharge standards for inorganic CoCs without polishing. However, sulfide precipitation would not be effective at removing arsenic. Treatability testing would be necessary. Neutralization, to lower the pH of the treated effluent, would be necessary before discharge. Ferrihydrite precipitation is a potentially effective form of treatment. In this process, ferric oxides and hydroxides are formed, and other contaminants are adsorbed/coprecipitated with these precipitates. In this case, oxidation of the extracted groundwater may be necessary to facilitate formation of the ferric hydroxides and oxides. Also, additional iron may need to be added to the solution to guarantee enough ferric hydroxides to result in the maximum removal efficiency possible for the other CoCs. Some sort of polishing, such as phosphate precipitation, is necessary to remove any excess iron before discharge. Ferrihydrite precipitation may not be effective, however, for some CoCs, including cadmium and zinc.

In an ion exchange process, unwanted (hazardous) ions are replaced in solution by innocuous ions from an ion exchange material (usually a synthetic resin). Typically, some contaminants are also adsorbed onto the resin. Ion exchange resins can, depending on their design, remove metallic ions, other inorganics such as chlorides, sulfates, and organic acids and amines. The upper concentration limit for ion exchange is 2,500 to 4,000 mg/L of contaminants (EPA, 1987). At concentrations above this, pretreatment of aqueous solution is necessary. At the Old Landfill/ Clark Tailings site, ion exchange may be effective for the removal of metallic CoCs, such as zinc and iron, without pretreatment. A combination adsorption/ion exchange system could be employed to remove organic CoC, also. Ion exchange system costs tend to be higher than precipitation.

Reverse osmosis (RO) involves forcing a solution through a membrane that is designed to retain certain solvent molecules (contaminants) while allowing the solute (water) to pass. RO is used to remove both organic and inorganic contaminants. For contaminated groundwater treatment RO is generally limited to polishing of low flow streams (EPA, 1987). Also, RO units are very costly to construct and operate. Therefore, it would most likely not be cost effective at the Old Landfill/Clark Tailings and will not be considered further at this time.

Many process options exist for on-site treatment of the volatile organic CoCs. These include air stripping, adsorption, oxidation, and biological treatment Each is described briefly below.

Air stripping is a proven technology with a successful track record of removing volatile organics from water (EPA, 1987). Packed-column air stripping units have achieved 80% removal efficiencies for volatile organics at air to water ratios as low as 9.3:1 (Canter and Knox, 1985). As the air:water ratio increases, the removal efficiency increases. In an air stripping application, the air to water ratio is selected based on the Henry's constant of the CoC and the removal efficiency required. Typical costs for air stripping, including amortized capital costs, range from $0.20 to 0.65 per 1000 gallons treated per year (EPA, 1987). Many air stripping processes are used, including packed columns (towers), diffused air-basins, and cross-flow towers.

Carbon adsorption is the most common form of adsorption applied to volatile organics in water. The activated carbon selectively adsorbs organic constituents by surface attraction. Adsorption depends on the strength of the molecular attraction between the contaminant and the activated carbon, electrokinetic charges, and surface area. Once the activated sites on the carbon are occupied, the carbon is "spent", at which time it is replaced. The spent carbon is typically reactivated (regenerated) at an off-site facility. In addition to organics, many inorganics are adsorbed to carbon, but inorganic CoC at the site are not readily adsorbed to carbon (EPA, 1987). Operation and construction costs for activated carbon range depending on the capacity of the unit and contaminant loading rates.

Biological treatment of volatile organics results in the mineralization of the contaminants by biological processes. Aerobic and anaerobic processes are available. Aerobic processes may include activated sludge, extended aeration, and fixed-film reactors such as rotating biological contractors (RBCs) and trickling filters. Biological treatment may also be effective in treating inorganic CoCs at the site. However, the effectiveness of most biological treatment, particularly aerobic processes, is very sensitive to process control. Therefore, extensive O&M costs are typically incurred.

Constructed wetlands combine physical, chemical, and biological processes to remove metals and organics from solution. Contaminants are removed via precipitation, ion exchange, adsorption, and biodegradation. Reducing environments within the wetlands result in precipitation of metals, which are then removed via sedimentation. Metals are also adsorbed onto the organic matter within the wetlands. Organic contaminants may be adsorbed and/or mineralized in oxidizing zones of the wetlands. ARCO is currently conducting demonstration

projects as part of Superfund activities in the Butte area to determine the effectiveness of constructed wetlands.

Based on the information presented above, performance history, and costs, the most likely process option for this alternative would be on-site air stripping to remove VOCs followed by ion exchange to remove inorganic contaminants. While discharge to the POTW would most likely be the most cost-effective process option in urban settings, influent limitations at the Butte POTW would make pretreatment necessary. Therefore, this process option has not been selected for development and evaluation. Also, constructed wetlands may be an effective treatment process. Their effectiveness is currently undergoing testing as part of Superfund activities in the Butte area.

Effectiveness - This alternative would include the installation of a cap over the waste materials; this cap by itself may be effective at addressing groundwater contamination (as described under Alternative 3). If the cap does not address groundwater contamination, the effectiveness of groundwater removal and treatment is still not certain. It is often difficult to achieve GWPSs with pump-and-treat systems (EPA, 1990). Also, heterogenous soils do not lend themselves well to pump-and-treat systems (EPA, 1990). The alluvial aquifer beneath the combined site is very heterogenous. In heterogeneous soils, the water will follow the path of least resistance, possibly allowing contaminants to remain. Groundwater will move through the high permeability zones, removing those contaminants. The advected water will not move as well through the low permeability zones, allowing contaminants to remain (EPA, 1990). An EPA survey of groundwater remediation practices found that pump-and-treat is the most common form of groundwater remediation; however, very few pump-and-treat systems are successful at achieving GWPSs. Pump-and-treat technology for organic chemical contamination is probably not a cost-effective remedial technology in this setting.

Implementability - Technically, this alternative is implementable. The installation of groundwater extraction wells and treatment systems is a conventional technology. However, administrative feasibility is questionable. This technology may not achieve GWPSs (as discussed above), making administrative feasibility difficult. Installation of extraction wells would require attaining water rights. Direct discharge of treated water will require the acquisition of a Montana Pollutant Discharge Elimination System (MPDES) permit.

Cost Screening - Costs for this alternative are summarized on Table 6-11. The present worth value is estimated at $6,092,000. Costs of this magnitude would require BSB to raise current landfill rates. This cost estimate is based on a native soils cap on the Clark Tailings as described in Alternative 3. If a less permeable cap is required over the Clark Tailings to satisfy regulatory requirements (such as that described in Alternative 5), costs will increase approximately $1.5 million.

Screening Summary - This alternative is not expected to be any more effective at attaining GWPSs than other alternatives that are easier to implement and less costly. The failure of pump-and-treat systems to achieve GWPSs is well documented, as discussed previously. Therefore, this alternative is not retained for detailed analysis.

6.2.10 Alternative 10 - In Situ Groundwater Treatment with Capping and Institutional Controls

This alternative would involve treatment of the contaminated groundwater plume in place. In situ groundwater treatment options are generally applicable to organic contaminants, inorganics (heavy metals) are not amenable to these types of processes. In addition to in situ groundwater treatment under this alternative, a cap would be placed on the landfill and the Clark Tailings and hydraulic and institutional controls would be implemented. For the purposes of this assessment, the cap would be a native soil cap as described in Alternative 3. The cap could include lower permeability materials, such as those described in Alternatives 5 and 6, if it is determined to be necessary. The cap will be installed after LAO materials are imported and placed on the Clark Tailings portion of the site as described previously. Surficial tailings from the periphery of the Clark Tailings would be consolidated with the rest of the tailings.

Potentially applicable in situ groundwater treatment process options for the organic CoCs include air sparging/vapor extraction, bioremediation, and chemical oxidation. Each is described briefly below. Also, intrinsic remediation is potentially applicable at this site.

Air sparging has been effective at removing VOCs, including the organic CoCs present at this site, from groundwater in sandy soils; gravel, sand, silt soils; and silty clay soils (The Hazardous Waste Consultant, 1993). The air sparging well radius of influence for the gravel, sand, silt soil and the silty clay soils were approximately 30 feet (requiring injection wells on a minimum 60-ft centers). Air sparging involves pumping air via injection wells into the groundwater. The sparged air causes VOCs to volatilize and be liberated to the vapor phase (in both the vadose zone and the saturated zone). The vaporized contaminants can then be removed via a series of vapor extraction wells. Thermal oxidation of the extracted vapors or stripping of the vapors in carbon filters could be included to prevent the release of hazardous vapors to the atmosphere, if necessary.

Multiple wells would be required to adequately cover the extent of the contaminated groundwater plume. An estimated three injection wells would be required per acre. The extent of the VOC plume covers approximately 8 acres (the area around BSB-A2, BSB-A3, and BSB-A6); therefore, 24 sparge wells would be required. Blowers would provide the positive pressure to each sparging well causing the air to spread horizontally and rise vertically through the soil column. This allows organic contaminants present in the saturated zone to partition to the air stream and be mobilized out of the saturated zone.

After being transferred to the vadose zone, organic vapors can be removed by the vapor extraction wells. Additional blowers would provide suction to each vapor extraction well. The suction would produce a pressure gradient and cause air to be drawn through the pore spaces in

the vadose zone to the extraction wells. The flow of air through the vadose zone would volatilize organic contaminants present in the vadose zone material and remove organic vapors from the subsurface. The air flow created would also cause dissolved phase organic compounds present in vadose zone pore water to be volatilized and removed. Based on typical design standards, approximately five extraction wells per acre would be required.

A concern with air sparging is the potential to cause migration of landfill gas. By inducing a positive subsurface pressure in some areas, the subsurface flow of landfill gas may be affected. If this alternative were implemented, the design must consider the flow of landfill gas and monitoring of any potentially affected structures (such as buildings and utilities, particularly the buried Grove Gulch diversion) for explosive gases must conducted.

In situ bioremediation involves using injection/recovery wells or trenches to incorporate necessary nutrients (i.e., nitrogen and phosphorus) and oxygen to stimulate the activity of indigenous microorganisms within the zone of contamination. Injection systems may also be used to incorporate new populations of microbes if indigenous populations are not effective in degrading the organic CoCs.

In situ bioremediation is effective for a wide range of organic contaminant concentrations. The process involves injecting oxygen and nutrient-rich solutions at strategic locations within the groundwater plume to enhance oxidation and biodegradation of organic contaminants by indigenous populations of aerobic bacteria. The contaminants would be removed by bacterial uptake and metabolization of these carbon sources. The addition of nutrients and an oxygen source (such as injected air or hydrogen peroxide) would likely significantly enhance the degradation of the organic contaminants. Additionally, limited hydrologic management of the plume may be necessary to prevent the spread of the contaminated groundwater plume from its present dimensions.

In situ oxidation involves injecting an oxidizing agent (such as dilute hydrogen peroxide or warm air) into the groundwater to alter the hazardous constituents to reduce their toxicity or mobility, or to produce inert compounds from the original material. Oxidation is not an applicable option if LNAPL is present; however, no evidence of LNAPL has been observed in the landfill monitoring wells, thus far. The oxidants are used to decompose or oxidize organic contaminants under controlled conditions in the subsurface; the process is equivalent to chemical burning. The oxidizing agent is injected into the zone of contamination through injection wells at a controlled rate. The injection rate would have to be determined through laboratory and pilot testing. In general, in situ oxidation is comparable in cost to in situ bioremediation.

Intrinsic remediation is the naturally occurring degradation and attenuation of contaminants. Intrinsic remediation is apparently occurring at the site since GWPSs are not exceeded at wells downgradient of the site. While intrinsic remediation is apparently preventing the spread of contaminants, and the ensuing potential of exposure to humans via the groundwater pathway, it is most likely not capable of achieving GWPSs at the relevant point of compliance.

Based on the information presented above, air sparging is the process option selected for evaluation for this site.

Effectiveness - In situ treatment may be effective at treating VOC contamination. However, it is not expected to be as effective as source removal such as landfill gas venting. In situ groundwater treatment would need to be continued as long as gas is generated by the landfill. In situ treatment would not be effective for many inorganics (especially metals). However, the cap installed as part of this alternative may be effective at addressing the inorganic groundwater contamination. Under ideal conditions, the CoC-specific GWPSs for VOCs would likely be attained after full-scale operation of an in situ groundwater treatment system; however, the period of time required to reach attainment is not known, but would likely be measured in terms of several years. For the organic contaminants, in situ treatment would likely achieve lower residual contamination levels than with groundwater pump and treat operations, possibly at a lower cost. Preliminary pilot-scale testing would be required to verify the effectiveness of the treatment system. Pilot-scale testing would also be necessary to establish initial values for key operating parameters (i.e., rates and concentrations of air injection, hydrogen peroxide, and/or nutrient addition, etc.). Pilot-scale and full-scale treatment performance would be closely monitored on a routine basis, and operational adjustments could be made to optimize the effectiveness of the system.

Implementability - This alternative is technically and administratively feasible. The technologies involved are conventional and can be installed with locally available materials and equipment. One issue that may inhibit implementability is the concern that landfill gas migration may be exacerbated by this technology, possibly making this alternative unacceptable to the public.

Cost Screening - Costs for this alternative are summarized on Table 6-12. The present worth value is estimated at $3,159,000. This cost estimate is based on a native soils cap on the Clark Tailings as described in Alternative 3. If a less permeable cap is required over the Clark Tailings to satisfy regulatory requirements (such as that described in Alternative 5), costs will increase approximately $1.5 million.

Screening Summary - This alternative is not expected to be any more effective at attaining GWPSs than other alternatives that are easier to implement and less costly. In situ groundwater treatment will most likely not address inorganic groundwater contamination; and landfill gas extraction is expected to be more effective at achieving GWPSs for VOCs. Therefore, this alternative is not retained for detailed analysis.

6.3 SUMMARY OF ALTERNATIVE SCREENING

Each of the alternatives is briefly described and compared in Table 6-13.

7.0 DETAILED ANALYSIS OF ALTERNATIVES

The MDEQ Solid Waste Regulations contain criteria which must be considered during the analysis and selection of corrective measures. The corrective measures alternatives retained following the screening process (presented in Section 6.0) will be evaluated individually against the following criteria, in accordance with ARM 17.50.710(7)(c):

- long- and short-term effectiveness;
- ability to provide source control;
- implementability;
- practicable capability of owner; and
- degree to which community concerns are addressed.

Each of the evaluation criteria are explained in the following paragraphs.

Long- and Short-Term Effectiveness

Effectiveness is evaluated based on the performance, reliability, and potential impacts of appropriate potential remedies (including safety impacts, cross-media impacts, and control of exposure to any residual contamination). The long-term effectiveness and permanence of each alternative with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage remaining wastes over the long term is considered. In addition, the time required for protection to be achieved was evaluated. Short-term effectiveness was evaluated by examining the effectiveness and protectiveness of each alternative in protecting human health and the environment during the construction and implementation of the remedy.

Ability to Provide Source Control

This criterion provides a forum to judge how well an alternative uses containment technologies to reduce the threat of further containment releases and the extent to which treatment technologies would be utilized.

Implementability

This criterion addresses the ease or difficulty in implementing the alternative, including an assessment of the degree of difficulty in construction; operational reliability; permitting requirements; availability of equipment and expertise; and the capacity of any necessary waste management services.

Practicable Capability of Owner

The ability of the owner/operator to both technically and financially complete and maintain a particular corrective measure is discussed under this criterion.

7.0 DETAILED ANALYSIS OF ALTERNATIVES

The MSWLD Solid Waste Regulations contain criteria which must be considered during the analysis and selection of corrective measures. The corrective measures alternatives identified following the screening process presented in Section 6.0 will be evaluated individually against the following criteria, in accordance with ARM 17.50.710(2)(a):

- Long- and short-term effectiveness;
- ability to provide source control;
- implementability;
- practicable capability of owners and
- degree to which community concerns are addressed.

Each of the evaluation criteria are explained in the following paragraphs.

Long- and Short-Term Effectiveness

Effectiveness is evaluated based on the performance, reliability, and potential impacts of appropriate potential remedies (including safety impacts, cross-media impacts, and control of exposure to any residual contamination). The long-term effectiveness and performance of each alternative is considered in the magnitude of residual risk and the adequacy and reliability of controls used to manage remaining wastes over the long term is considered. In addition, the time required for protection to be achieved was evaluated. Short-term effectiveness was evaluated by examining the effectiveness and protectiveness of each alternative in protecting human health and the environment during the construction and implementation of the remedy.

Ability to Provide Source Control

This criterion provides a means to judge how well an alternative uses containment technologies to reduce the threat of further contaminant releases and the extent to which treatment technologies would be utilized.

Implementability

This criterion addresses the ease or difficulty in implementing the alternative, including an assessment of the degree of difficulty in constructing or operation and reliability, permitting requirements, availability of equipment and experts, and the capacity of any necessary waste management services.

Practicable Capability of Owners

The ability of the owner/operator to both technically and financially complete and maintain a particular corrective measure is discussed under this criterion.

Community Concerns

This criterion reflects the community's apparent preferences for or concerns about each alternative. A more comprehensive evaluation of community reaction will be made following receipt of public comments on this assessment during a forthcoming public meeting.

7.1 ALTERNATIVE 1 - NO ACTION

This alternative includes no additional action at the site. Capping activities would not be completed on the Old Landfill, and the cap on the Clark Tailings would not be repaired or improved. The potential for erosion of mine wastes and soils would remain, possibly impacting surface water quality. Groundwater contamination would most likely persist.

Long- and Short-Term Effectiveness - The no action alternative will not reduce risks and will not provide adequate and reliable long-term controls to manage wastes. It will not provide adequate protection of human health. It would not help to attain GWPSs at the site.

Ability to Provide Source Control - This alternative would not employ containment or treatment technologies to control sources of waste at the site. Leachate generation would continue to be a possible source of inorganic groundwater contamination and landfill gas would continue to be a possible source of VOC groundwater contamination.

Implementability - There are no implementability issues associated with this alternative.

Practicable Capability of Owner - This alternative includes no corrective measures; the capability of the owner to implement this alternative is not an issue.

Community Concerns - This criterion will be addressed after a public meeting regarding the Old Landfill/Clark Tailings site and after receiving public comments on this report.

7.2 ALTERNATIVE 4 - NATIVE MATERIALS CAPPING WITH INSTITUTIONAL CONTROLS

This alternative includes completing capping of the Old Landfill in accordance with solid waste regulations; importing LAO materials to the Clark Tailings; consolidating surficial tailings from the periphery of the Clark Tailings; grading and capping of the Clark Tailings with a minimum 18-inch cover; installing hydraulic controls to prevent run-on, promote run-off, and control erosion; and implementing institutional controls to prevent development of the site or aquifer in a manner that may harm human health.

Long- and Short-Term Effectiveness - This alternative will be effective in the long-term at preventing direct exposure to wastes and at preventing erosion of materials and subsequent surface water contamination. The alternative would provide this protection as soon as the caps are installed and revegetated (within one year of implementation). It will

substantially lessen the amount of infiltration and leachate production; this will thereby lessen the flux of leachate-based contaminants, particularly inorganics, to the groundwater. Improvements in groundwater quality at the point of compliance are expected to be observed in eight to ten years. This alternative will not address landfill gas, the probable source of VOC groundwater contamination. Therefore, significant improvements in VOC concentrations are not expected. However, by implementing a controlled groundwater use zone through the BSB Water Quality District and DNRC, human health will be protected by not allowing development of the affected aquifer.

This alternative includes proven and reliable, permanent technologies. The alternative would not create any residual wastes requiring management or treatment.

In the short-term, this alternative would not pose any significant threats to human health and the environment. BMPs, including establishing vegetation, would be employed to control erosion during construction. Dust suppression techniques would be used to prevent inhalation of airborne wastes. Heavy equipment used to construct the caps may pose a safety threat to construction workers, but safety programs and controls would be used to minimize this threat. Importing cover materials would require traffic safety programs to minimize threats posed to the public by increased heavy truck traffic in the vicinity of the site.

Ability to Provide Source Control - Alternative 4 would provide excellent source control for the direct contact and surface water exposure pathways. However, some flux of contaminants from the waste material sources to groundwater may continue to occur, via existing pore water in the waste, limited infiltration of precipitation, and landfill gas production. Therefore, the degree of source control for this alternative is considered moderate.

Implementability - This alternative is technically and administratively implementable. The equipment, materials, and expertise to construct the native soil caps are locally available. The construction techniques are conventional and the site poses no significant construction challenges. Once the caps are installed, minimal maintenance of the site will be required, so operational reliability is considered good. A MDEQ Storm Water Discharge permit will be required for construction activities; no other permits will be required. No residual wastes will be generated, so there are no concerns over residual waste management.

A GWCA will be established through the BSB Water Quality District and the DNRC. This area will prevent the development of the affected aquifer in a manner that may be detrimental to human health or may cause the contaminant plume to migrate.

Practicable Capability of Owner - BSB and ARCO are fully capable, both technically and financially, of implementing this alternative.

Community Concerns - This criterion will be addressed after a public meeting regarding the Old Landfill/Clark Tailings site and after receiving public comments on this report.

7.3 ALTERNATIVE 5 - LOW PERMEABILITY CAPPING WITH INSTITUTIONAL CONTROLS

This alternative includes completing capping of the Old Landfill in accordance with solid waste regulations. It also includes grading and capping of the Clark Tailings with a low permeability cap consisting of an infiltration barrier layer, a capillary break/drainage layer, and an 18-inch cover soil/vegetative growth medium layer. The Clark Tailings will be capped in this manner after importing and placing LAO materials at the site and consolidating surficial tailings from the periphery of the Clark Tailings. Also, hydraulic controls would be installed to prevent run-on, promote run-off, and control erosion; institutional controls would be implemented to prevent development of the site or the aquifer in a manner that may harm human health.

Long- and Short-Term Effectiveness - This alternative will be effective in the long-term at preventing direct exposure to wastes, preventing erosion of materials and subsequent surface water contamination, and minimizing infiltration of precipitation. The alternative would provide this protection as soon as the caps are installed and revegetated (within one year of implementation). The low permeability cap on the Clark Tailings will significantly lessen the amount of infiltration and leachate production (by nearly 60% over the pre-closure conditions, according to HELP modeling results). This will reduce the flux of leachate-based contaminants to the groundwater. In this manner, this alternative is expected to meet GWPSs for inorganic CoCs such as cadmium. Improvements in inorganic concentrations at the point of compliance wells are expected in eight to ten years. However, this alternative will not address landfill gas, the probable source of VOC groundwater contamination. However, VOCs have not been detected above GWPSs downgradient of the site. Furthermore, by implementing a controlled groundwater use zone, human health will be protected by not allowing development of the affected aquifer for potable water.

This alternative includes proven and reliable, permanent technologies. The alternative would not create any residual wastes requiring management or treatment.

In the short-term, this alternative would not pose any significant threats to human health and the environment. BMPs would be employed to control erosion during construction. Dust suppression techniques would be used to prevent inhalation of airborne wastes. Heavy equipment used to construct the caps may pose a safety threat to construction workers, but safety programs and controls would be used to minimize this threat. Importing cover materials would require traffic safety programs to minimize threats posed to the public by increased heavy truck traffic in the vicinity of the site.

Ability to Provide Source Control - Alternative 5 would provide excellent source control for the direct contact and surface water exposure pathways. It is also expected to provide good

source control for inorganic contaminants by installing the low permeability cap. However, this alternative will not control landfill gas, the likely source of VOC contamination in groundwater.

Implementability - This alternative is technically and administratively implementable. The equipment, materials, and expertise necessary to construct the soil caps are locally available and testing conducted to date shows that the materials are capable of meeting the permeability specifications for this alternative. The construction techniques are conventional and the site poses no significant construction challenges. Once the caps are installed, minimal maintenance of the site will be required, so operational reliability is considered good. A MDEQ Storm Water Discharge permit will be required for construction activities; no other permits will be required. No residual wastes will be generated, so there are no concerns over residual waste management.

A GWCA will be established through the BSB Water Quality District and the DNRC. This area will prevent the development of the affected aquifer in a manner that may be detrimental to human health or may cause the contaminant plume to migrate.

Practicable Capability of Owner - BSB and ARCO are fully capable, both technically and financially, of implementing this alternative.

Community Concerns - This criterion will be addressed after a public meeting regarding the Old Landfill/Clark Tailings site and after receiving public comments on this report.

7.4 ALTERNATIVE 8 - LANDFILL GAS REMOVAL WITH CAPPING AND INSTITUTIONAL CONTROLS

This alternative is very similar to Alternative 5 with the addition of passive landfill gas removal (via venting). In addition to landfill gas removal, it includes completing capping of the Old Landfill in accordance with solid waste regulations; importing LAO materials to the Clark Tailings; consolidating surficial tailings from the periphery of the Clark Tailings with the rest of the tailings; grading and capping of the Clark Tailings with a low permeability cap; installing hydraulic controls to prevent run-on, promote run-off, and control erosion; and institutional controls to prevent development of the site or the aquifer in a manner that may harm human health.

Long- and Short-Term Effectiveness - This alternative will be effective in the long-term at preventing direct exposure to wastes and at preventing erosion of materials and subsequent surface water contamination. The alternative would provide this protection as soon as the caps are installed and revegetated (within one year of implementation). The low permeability cap on the Clark Tailings will significantly lessen the amount of infiltration and leachate production (by nearly 60% over pre-closure conditions, according to HELP modeling results). This will lessen the flux of leachate-based contaminants to the groundwater by a comparable percentage. In this manner, this alternative is expected

to meet GWPSs for inorganic CoCs such as cadmium. By removing the probable source of VOC groundwater contamination (landfill gas), this alternative is expected to attain GWPSs for organic contaminants, also. Once these improvements are installed, the length of time until GWPSs are achieved is difficult to predict. Improvements in organic contaminant concentrations may be observed within a few years since the source of VOCs is being removed. Inorganics, however, may take longer to meet GWPSs. The interstitial water currently within the wastes moves very slowly, particularly through the Clark Tailings. Once the cap is installed, the flux of inorganic contamination will lessen. However, it will take some time (on the order of three to four years) until the water currently in the waste drains from it. Once this water drains from the Clark Tailings and reaches the aquifer, it will take several years to reach the monitoring wells. Therefore, it is expected to be eight to ten years before improvements in inorganic levels are seen in the point of compliance wells. By implementing a controlled groundwater use zone through the BSB Water Quality District, human health will be protected in the interim by not allowing development of the affected aquifer for potable water.

This alternative includes proven and reliable, permanent technologies. The alternative would not create any residual wastes requiring management or treatment.

In the short-term, this alternative would not pose any significant threats to human health and the environment. BMPs would be employed to control erosion during construction. Dust suppression techniques would be used to prevent inhalation of airborne wastes. Heavy equipment used to construct the caps may pose a safety threat to construction workers, but safety programs and controls would be used to minimize this threat. Importing cover materials would require traffic safety programs to minimize threats posed to the public by increased heavy truck traffic in the vicinity of the site.

Ability to Provide Source Control - Alternative 8 would provide excellent source control. It would prevent direct contact and surface water exposure as soon as the caps are installed and revegetated. It is also expected to provide good source control for inorganic contaminants by installing the revegetated native soils and low permeability cap. By venting landfill gas, the source of VOC contamination is removed from the site.

Implementability - This alternative is technically and administratively implementable. The equipment, materials, and expertise to construct the soil caps are locally available and testing conducted to date shows that the materials are capable of meeting the permeability specifications for this alternative. The construction techniques are conventional and the site poses no significant construction challenges. Once the caps are installed, minimal maintenance of the site will be required, so operational reliability is considered good. The landfill gas venting system may require periodic maintenance and monitoring, also. A MDEQ Storm Water Discharge permit will be required for construction activities; no other permits will be required.

The only residual waste from this process is the landfill gas which will be vented to the atmosphere. The venting would be done in accordance with waste management regulations. Based on the available data, the landfill gas discharge will not require permitting under air quality regulations. Montana air quality regulations require a permit if the source emits more than 25 tons per year of NMOCs; the landfill is conservatively expected to produce no more than 8.5 tons per year of NMOCs (see Appendix E). Also, the capacity of the landfill is not large enough to require an active landfill gas collection system under EPA's NSPS.

A GWCA will be established through the BSB Water Quality District and the DNRC. This area will prevent the development of the affected aquifer in a manner that may be detrimental to human health or may cause the contaminant plume to migrate.

Practicable Capability of Owner - BSB and ARCO are fully capable, both technically and financially, of implementing this alternative.

Community Concerns - This criterion will be addressed after a public meeting regarding the Old Landfill/Clark Tailings site and after receiving public comments on this report.

8.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

All alternatives considered in the detailed evaluation, with the exception of the no action alternative, will provide long-term effectiveness at controlling direct contact and surface water contamination. Alternatives 5 and 8 are expected to achieve GWPSs for inorganics via the installation of a low permeability cap over the Clark Tailings and a cap in accordance with solid waste regulations over the landfill. Furthermore, the caps included in the these alternatives satisfy regulatory requirements for closure at ARM 17.50.530. Alternative 4 is expected to achieve GWPSs for inorganics; however, it does not provide the level of regulatory compliance (particularly with respect to the cap requirements for areas where wastes are placed after October 9, 1991, which will be the case at the Clark Tailings after the LAO materials are placed there) as Alternatives 5 and 8. Only Alternative 8 is expected to achieve GWPSs for volatile organics, via source removal (landfill gas venting).

Improvements in inorganic CoC levels in monitoring wells are expected to be comparable for Alternatives 4, 5, and 8. Only Alternative 8 is expected to achieve GWPSs for organics.

All alternatives (with the exception of the no action alternative) offer comparable short-term risks, associated primarily with traffic and construction equipment. These risks would be minimized under each alternative by implementing construction and traffic safety programs.

Alternative 8 is expected to provide the greatest source control by containing the inorganic wastes via capping and removing the source of organic contamination via landfill gas venting. Alternative 5 will offer the same level of inorganic containment, but will not control organic contaminant sources. Alternative 4 will provide nearly as thorough inorganic containment, but will not address organic sources. Alternative 1 (no action) will not provide adequate source control.

Each alternative is considered technically and administratively implementable. Also, BSB and ARCO are financially and technically capable of implementing each alternative.

9.0 PREFERRED ALTERNATIVE

Alternative 8, Landfill Gas Removal with Capping and Institutional Controls, is the preferred alternative for addressing groundwater contamination at the Old Landfill/Clark Tailings site. The alternative is expected to meet the goals of the corrective measures process identified in Section 4. It satisfies the evaluation criteria as well as or better than the other alternatives, as described in Section 8. The alternative applies conventional, implementable technologies to address the groundwater contamination at the site. It will meet or exceed regulatory standards for landfill closure.

The alternative is expected to achieve GWPSs for metals (particularly cadmium and zinc) through the installation of a low permeability cap over the primary source of these contaminants, the Clark Tailings. First, the Clark Tailings site will be graded to promote run-off from the waste areas and prevent run-on to these areas. A lined pond will be installed south of the tailings in an area that currently ponds. This ponded water currently evaporates or infiltrates; infiltration raises the groundwater table, possibly into the Clark Tailings in some areas. The Timber Butte Sedimentation Basin, near the northeastern corner of the Clark Tailings, will be lined to minimize infiltration through tailings in this area. By installing these lined ponds, the amount of leachate from theClark Tailings, and, therefore the flux of metals from the tailings to the groundwater, will be reduced. These ponds may also be used as an irrigation source for the planned recreational facilities at the site. Other hydrologic controls will include interceptor berms and run-off ditches to convey water off the site as quickly as possible while minimizing erosion. Shallow-sloped diversions will also be lined in areas that cross tailings. This will also minimize infiltration.

A MPDES general permit to discharge storm water associated with construction activities will be aquired from the MDEQ Permitting and Compliance Division before construction activities associated with implementing the selected corrective measures are commenced. To comply with this permit, BMPs will be employed as interim measures at the site to mitigate erosion potential before and during construction activities. No other interim measures are necessary with this alternative.

Prior to installation of the cap, the tailings will be consolidated as much as practicable to minimize the area requiring a cap. This will primarily involve excavating the surficial tailings from the periphery of the Clark Tailings. The excavated materials will be placed on top of the Clark Tailings. The excavated areas will be backfilled with clean cover soil and graded to promote drainage. Then, the materials from the LAO will be imported to the site and placed over the Clark Tailings. These materials will be placed in a manner conducive with the intended use of the site for recreational facilities. This will include placing and compacting the materials in a manner that will allow development of the site. In general, materials will be placed at a minimum of 90% of their maximum dry density, as determined by ASTM D698. Under areas on which permanent improvements may constructed (such as structures or parking lots), the

materials would be placed to a minimum of 95% of their maximum dry density. The area will be graded to promote run-off and in preparation for its use as a recreational facility.

After preparation of the Clark Tailings site is complete, the cap itself will be installed. The cap is designed to significantly reduce infiltration and the resulting generation of leachate. A typical cross-section of the cap is shown on Figure 6-3. The cap will consist of a prepared subgrade overlaid by 18 inches of low permeability soils (on the order of 1.0E-05 to 1.0E-07 cm/sec) as an infiltration barrier layer. Installation of these materials will be monitored closely to ensure consistent low permeability throughout this crucial layer. Over the infiltration barrier layer, a six-inch layer of coarse materials will be placed. This layer will serve several purposes. First, as a capillary break it will prevent the capillary rise of contaminants from the waste materials to overlying soils. This will, in turn, help to ensure a healthy vegetative cover. Secondly, as a drainage layer, it will provide a highly permeable medium for which water that has infiltrated through the overlying cover soils to drain by gravity from the cap before infiltrating through the infiltration barrier layer. This will decrease the overall head on the infiltration barrier layer and the overall leachate generation rate. The coarse materials will also prevent the downward growth of roots, preventing root damage to the underlying barrier layer. Over the capillary break/drainage layer, a 12-inch layer of cover soil will be installed and then an additional 6-inch seed bed layer will be added. These soils will provide a medium for vegetative growth and will also provide a reservoir for moisture storage. In other words, these soils will store moisture until such a time that it can be evapotranspired. In this way, the amount of water infiltrating through the cap is reduced.

Areas that will be paved, such as parking areas and roads, as part of the planned recreational complex at the site may be capped in a different manner. These areas may be capped with a native soil cover overlaid by base coarse (which will serve as capillary break and drainage layer and will prove strength to the overlying asphalt) and flexible asphalt pavement. The asphalt pavement will act as the infiltration barrier layer. These areas will be graded to promote run-off. Run-off will account for the majority of the water balance in these areas, rather than evapotranspiration. The pavement will be designed to minimize cracking potential, and the asphalt will be maintained to promptly fix any cracks or holes. This is similar to the portions of the cap installed at the Old Works/East Anaconda Development Area Operable Unit near Anaconda, Montana.

A detailed final grading plan for the Clark Tailings, after placement and compaction of the LAO materials and installation of the cap, is shown on Figure 9-1.

Infiltration of precipitation through the landfill is not expected to be a major source of groundwater contamination, as explained in Section 5. Therefore, a cap designed to comply with regulatory standards will be installed at the landfill portion of the site. The majority of the earthwork for the landfill cap has been completed; as of December 1996, approximately seven acres require additional capping, as explained in Section 6.2.3. The additional cover will be installed and the entire area will be finish-graded and revegetated. This cap will reduce

infiltration by providing positive drainage from the site and increasing the evapotranspiration. The vegetated cap will minimize erosion and the mobility of wastes by the surface water pathway. It will also prevent exposure to wastes via direct contact and airborne-migration of wastes.

A passive landfill gas venting system will be incorporated into the landfill cap in the northeastern portion of the landfill (the area where GWPSs for selected VOCs have been exceeded). This system will be designed to collect and vent landfill gases to the atmosphere, thereby decreasing the landfill gas pressure within the landfill and the resulting migration of landfill gas, contact with groundwater, and transfer of VOCs from the gaseous to the aqueous phase. This system will remove the source of the VOC contamination, preventing further groundwater degradation. VOCs presently in the groundwater will be treated intrinsically, and GWPSs for VOCs will be achieved with time. A schematic for the landfill gas venting system is shown on Figure 9-2.

In addition to these measures, institutional controls will be implemented to ensure protection of human health. These controls will consist of restrictive covenants placed in the property deeds to prevent their development in a manner that may lead to exposure of contaminants to humans. Also, the zoning for the area will be maintained as recreational/open-space to prevent residential development. The groundwater monitoring program at the site will be continued, as explained in Section 10. This plan will measure the effectiveness of the implemented corrective measures and will also be used to ensure that contaminants are not migrating from the site to downgradient users of the affected aquifer. Furthermore, a GWCA will be instituted, via the BSB Water Quality District and DNRC to prevent the development and/or use of the affected aquifer in a manner that may be harmful to human health and the environment. The aquifer could not be used as a potable water supply. Also, the aquifer could not be used in the vicinity of the site for industrial or other large-scale uses that may create a regional cone of depression that may lead to contaminant migration.

Groundwater monitoring conducted after capping is completed and landfill gas venting is implemented will be used to measure the effectiveness of the implemented alternative. With respect to VOCs, landfill gas venting will control the source of contamination. Therefore, improvements in water quality can be expected in the time frame for currently contaminated water to travel beyond the monitoring points (in particular well BSB-A6). (Note that beyond this monitoring point, VOCs are apparently treated intrinsicly since no exceedences of GWPSs have been observed beyond this point.) It is known that groundwater contamination exists at the landfill border (as evidenced by BSB-A2 and BSB-A3). Therefore, improvements in well BSB-A6 will not be observed until this already contaminated water from the landfill boundary flows past BSB-A6 and is replaced with cleaner water that represents water quality after implementation of the corrective measures. The travel distance from the landfill boundary to BSB-A6 is approximately 450 feet and the hydraulic gradient in this vicinity is 4.5 percent. The travel time calculation is very sensitive to the hydraulic gradient estimate for the aquifer materials, which is difficult to measure or predict for the heterogeneous aquifer materials.

Based on the available data, the hydraulic conductivity is most likely in the vicinty of 1.0E-03 cm/sec. Based on this estimate, it will take 4.7 years to complete one flush of the VOC-contaminated aquifer above well BSB-A6 (based on the known upgradient extent of the VOC plume). Travel time calculations are included in Appendix G. Improvements to water quality can be expected after one flush has been completed in 4.7 years. It may take up to five flushes of the aquifer (or up to 23 years) before water quality meets groundwater protection standards or reaches background concentrations. Some information available from the geoprobe investigation suggests that landfill gas may be migrating from landfill and then contacting groundwater downgradient of the landfill boundary. If this is the case, passive venting of landfill gas may improve water quality more quickly than the time frames discussed above. The groundwater monitoring program for measuring the effectiveness of the preferred alternative is presented in Section 10.

Improvements in groundwater quality with respect to inorganics will be driven by the time for water to drain from the Clark Tailings and travel to the monitoring points. Based on a hydraulic conductivity of the tailings of 5.0E-05 cm/sec and an average depth of 47 feet (22 feet through tailings and 25 feet through alluvium overlying the aquifer) to the aquifer, it will take from 3.7 years for the water currently within the tailings to drain to the aquifer (calculations are included in Appendix G). Once the leachate reaches the aquifer, travel time to the point of compliance will depend on aquifer characteristics. As with the landfill portion of the site, the anticipated hydraulic conductivity of the aquifer below the Clark Tailings is anticipated to be in the vicinity of 1.0E-03 cm/sec.

Based on the available data and the estimated hydraulic conductivity of the aquifer, it will take 12.4 years to complete a flush of the contaminated aquifer below the Clark Tailings (Appendix G). It may take a few flushes of the aquifer before all residual metals in the aquifer are removed and GWPSs for inorganics are achieved at the point of compliance. However, as discussed in Section 5, infiltration from the Timber Butte Sedimentation Basin is expected to be a large contributor to the high zinc concentrations in well CLK-1. The travel distance from the upper portions of the Timber Butte Sedimentation Basin to well CLK-1 is approximately 400 feet. The calculated time to complete a single flush of the aquifer below the Timber Butte Sedimentation Basin is 3.7 years (Appendix G). Coupled with the estimated time to drain the presumablyl contaminated water within the tailings (3.7 years), a trend toward compliance with GWPSs should be observed in 6.7 years. Compliance with GWPSs may take much longer, based on the time to flush the currently contaminated groundwater from the upgradient areas of the Clark Tailings to the monitoring points. Based on the calculations provided in Appendix G, full compliance with GWPSs may require up to five full flushes of the currently contaminated aquifer, which could take up to 65 years. The time required may very well be less if the aquifer materials are more permeable than estimated or if less than five flushes are required. The groundwater monitoring program for measuring the effectiveness of the preferred alternative is presented in Section 10.

This schedule for compliance with GWPSs meets the requirements of the regulations and the needs of BSB. The corrective measures in the preferred alternative are capable of achieving

GWPSs with time. Wastes generated during implementation of the corrective measures will be minimal and can be handled easily with currently available waste management facilities in the area. Groundwater removal and treatment is significantly costlier than the preferred alternative, may not result in compliance with GWPSs any quicker than the preferred alternative, and its effectiveness is marginal. The extent and nature of the existing contamination do not present a threat to human health. A controlled groundwater use area will be established to further limit the exposure of humans to contamination. The affected aquifer is not currently used as a resource and there are no plans to develop it as a resource. After implementing the corrective measures, there will be no threat to wildlife, crops, vegetation, and physical structures. Furthermore, if another source of water is required for some unforeseen reason, water from the public water supply is available nearby (a water main runs down Montana Street east of the site).

If the groundwater monitoring program does not indicate a trend toward compliance in the time frame discussed above, BSB will re-address the site (with the assistance of ARCO, if the problems are with respect to the Clark Tailings) to determine if additional or different corrective measures are required. Re-addressing the site may require collection of additional data to more precisely determine the effectiveness of the implemented corrective measures. If it is determined that additional corrective measures are necessary, they may include corrective measures that address groundwater directly (such as those discussed within this document), further source control measures, or new technologies.

After implementation of these corrective measures, the area may be developed as a recreational complex. An architect's rendering of the potential layout of the facilities is shown on Figure 9-3. The grading plan for the closure of the site is intended to be conducive to the development of these recreational facilities. Construction of facilities such as these may require the installation of an irrigation system. If this is the case, the lined pond south of the Clark Tailings may be used for water storage. In addition to the surface water that flows into the pond, groundwater extraction wells may be installed in the vicinity of the site. These wells would be located in a manner that would not extract contaminated groundwater that may be inappropriate for irrigation. Irrigation of capped waste areas would be planned so as to not lead to the generation of more leachate than is predicted naturally. In the conceptual plan, irrigation is planned only over the Clark Tailings, which includes a low permeability cap, a drainage layer, and an 18-inch cover soil/evapotransporation layer.

10.0 CORRECTIVE MEASURES GROUNDWATER MONITORING PLAN

The existing groundwater monitoring wells at the site are shown on Figure 2-3. Wells BSB-A1, BSB-A2, BSB-A3, and BSB-A4 were installed in 1993 for groundwater monitoring at the Old Landfill. The other wells have been installed since as part of the assessment of groundwater contamination and corrective measures process.

Upon implementation of the selected corrective measure alternative, well MBMG-2 (the background well) will be monitored semi-annually in accordance with ARM 17.50.710(1)(a)(v). Other wells will be monitored to determine the effectiveness of the corrective measures, as described below.

The monitoring program will establish separate monitoring points for the two distinct contamination types involved. The POC for organic "landfill" constituents will be defined by the facility property boundary no more than 150 meters downgradient from the landfill unit. At this time, wells BSB-A5 and BSB-A6 will be monitored to determine compliance for the landfill portion of the site. The POC for inorganic "tailings" constituents will be defined by the facility property boundary no more than 150 meters downgradient from the Clark Tailings unit.

At this time, wells CLK-1, and CLK-2 will be monitored to determine compliance for the Clark Tailings portion of the site.

The modified Assessment Monitoring program, in accordance with ARM 17.50.710(1)(a)(v), will be as follows.

Semi-Annual (Table I and Table II detects) Monitoring

Well MBMG-2 (background well)	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Dissolved Metals Cyanide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151)
Well BSB-A5	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Cyanide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151)

Well BSB-A6	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Cyanide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151)
Well CLK-1	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Dissolved Metals
Well CLK-2	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Dissolved Metals

Annual (full Table II) Monitoring

Well MBMG-2 (background well)	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Dissolved Metals Cyanide Sulfide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151) Organochlorine Pesticides & PCBs (Method 8081)
Well BSB-A5	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Cyanide Sulfide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151) Organochlorine Pesticides & PCBs (Method 8081)

Well BSB-A6	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Chem. Oxygen Demand, Nitrates Cyanide Sulfide Volatile Organics (Method 8260) Semi-Volatile Organics (Method 8270) Chlorinated Acids (Method 8151) Organochlorine Pesticides & PCBs (Method 8081)
Well CLK-1	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Dissolved Metals
Well CLK-2	Field Parameters (pH, temp.) Specific Conductance, Chloride, Sulfate Dissolved Metals

In addition, well BSB-A6 (which currently exceeds GWPSs for certain VOCs) will be monitored quarterly for VOCs (via EPA Method 8260) to assess the effectiveness of the implemented alternative at addressing VOC contamination.

Data from wells CLK-1 and CLK-2 will be used to measure the effectiveness the implemented alternative at addressing inorganic groundwater contamination. Because of the long period anticipated before GWPSs will be achieved at these wells, they will not be monitored any more frequently than semi-annually (as required by ARM 17.50.710(1)(a)(v)) to determine the effectiveness of this alternative at achieving inorganic GWPSs.

Wells BSB-A2, BSB-A3, and BSB-A4 will be impacted by the planned corrective measures. Wells BSB-A2 and BSB-A3 will be impacted by grading and drainage controls planned for the site. Well BSB-A4 will be impacted by the planned storm water pond south of the Clark Tailings. These wells will no longer define the point of compliance for either the landfill or the Clark Tailings. Therefore, they will be abandoned during construction of the corrective measures improvements.

Well BSB-A6 will also be impacted by filling plans for the site. The exising well BSB-A6 will be maintained for as long as practicable during implementation of the planned corrective measures as the Clark Tailings. However, at some point during construction it will be necessary to abandon well BSB-A6. Once the area around BSB-A6 has been brought to final grade, a new well will be installed in the location of the exisitng BSB-A6. The time between abandoning the exising BSB-A6 and installing a new well will be kept as short as practicable; it may result in one to two quarterly sampling events at BSB-A6 being missed.

The groundwater monitoring plan would revert to detection monitoring, in accordance with ARM 17.50.710(2) when the contamination levels drop to background levels. Post-closure monitoring would continue for 30 years after closure of the site is completed in accordance with ARM 17.50.721.

Groundwater sampling procedures will be in accordance with the groundwater sampling SOPs approved by MDEQ.

11.0 PROJECT SCHEDULE

The project schedule is shown on Figure 11-1. After review of this document by MDEQ, a public meeting will be held. After this meeting, this document will be updated, if necessary, and resubmitted to MDEQ for approval (in first quarter of 1997). After receiving approval from MDEQ, detailed design of the selected alternative will begin. Final closure of the landfill portion of the site should be completed in 1997. At the Clark Tailings portion of the site, the LAO materials will be imported and placed during 1997 and 1998. Capping activities on the Clark Tailings may begin in 1997, depending on the fill sequence and progress made by the Contractor. Capping of the Clark Tailings portion of the site will not be completed until 1998. Any additional corrective measures at the site would be implemented along with the installation of the caps.

12.0 PROJECT MANAGEMENT PLAN

The MDEQ Solid Waste Program serves as the lead agency for this project. BSB and ARCO are jointly responsible for the performance of the work as outlined within this CMA. BSB is the lead party for capping and corrective measures associated with the landfill portion of the site. ARCO will be the lead party for the closure and capping of the Clark Tailings portion of the site. BSB will also be responsible for the post-closure monitoring and maintenance of the combined site.

13.0 COMMUNITY RELATIONS PLAN

ARM 17.50.710(6)(d) requires that the results of this assessment must be discussed with interested and affected parties at a public meeting before a remedy is selected. Therefore, once additional site characterization tasks and the detailed analysis of alternatives are completed, and a preferred alternative is identified, a public meeting will be held. The notice of public meeting will be published in the local newspaper. After the public meeting, the public will have period to provide comments on the preferred alternative. After receiving public comments, a remedy will be selected that considers public input. Public comments will be addressed in the *Final Remedy Selection Report.*

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FIGURE 1-1
SITE VICINITY MAP
OLD BUTTE LANDFILL

N

PIONEER TECHNICAL SERVICES, INC.

SCALE: 1" = 24,000"

USGS 7 1/2 Minute Quadrangle, Butte South, MT

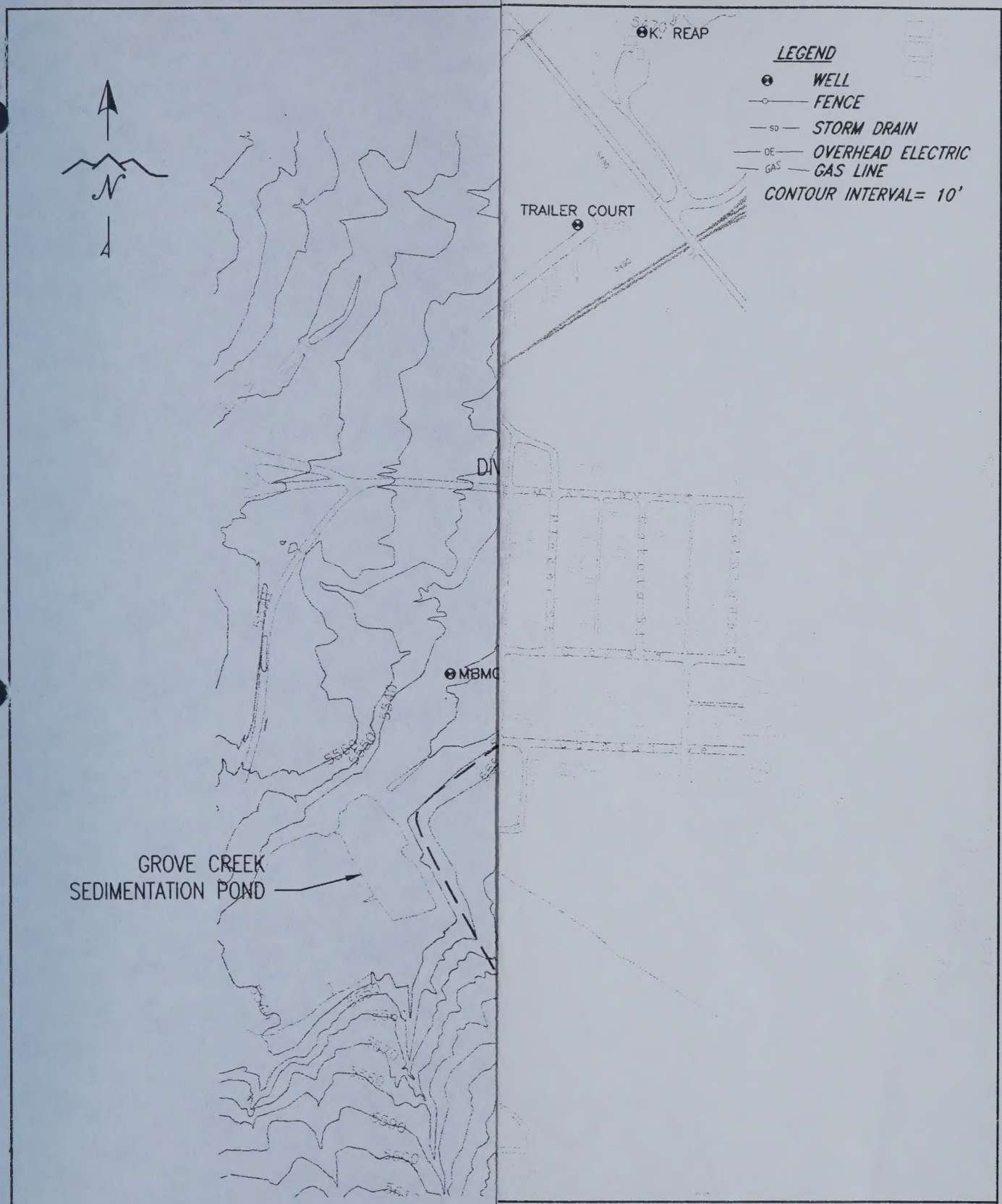


FIGURE 2-1
OLD LANDFILL/
CLARK TAILINGS
SITE MAP

SCALE: 1"=400'
DATE: 1/97

4502-F07

N

BLANKENSHIP

M. WHITE

CLK-2

K. REAP

LEGEND
- WELL
- FENCE
- SD — STORM DRAIN
- OE — OVERHEAD ELECTRIC
- GAS — GAS LINE
- CONTOUR INTERVAL= 10'

GROVE CREEK DIVERSION OUTLET

TRAILER COURT

CLK-1

TIMBER BUTTE SEDIMENTATION BASIN

MAN-MADE DITCH

BSB-A5

GROVE CREEK DIVERSION INLET

BSB-A1

CLARK TAILINGS

BSB-A6

MAN-MADE DITCH

MBMG-2

BSB-A2

OLD BUTTE LANDFILL

BSB-A3

GROVE CREEK SEDIMENTATION POND

EX. CMP

BSB-A4

PIONEER TECHNICAL SERVICES, INC.

FIGURE 2-1
OLD LANDFILL/
CLARK TAILINGS
SITE MAP

SCALE: 1"=400'
DATE: 1/97

4502-F07

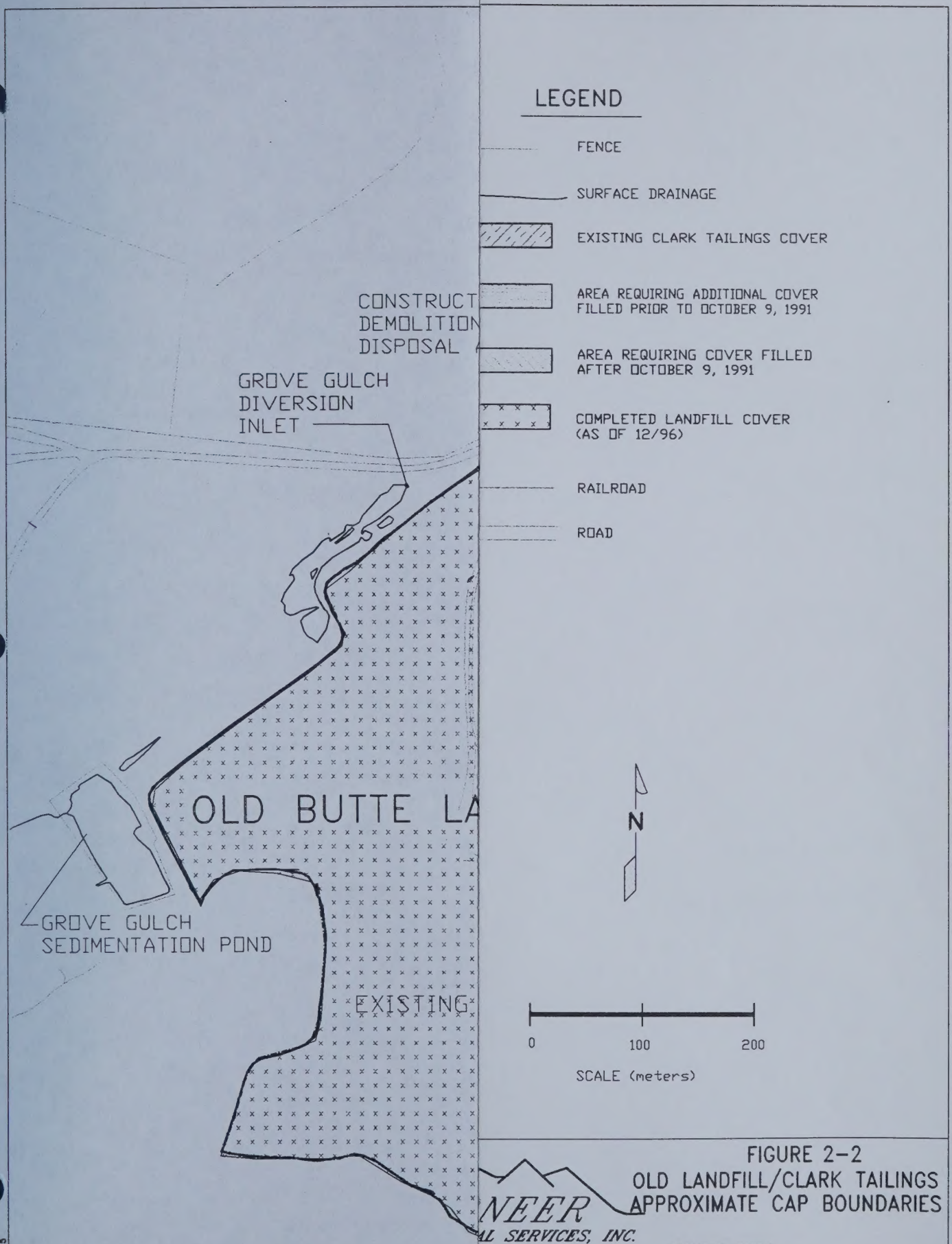
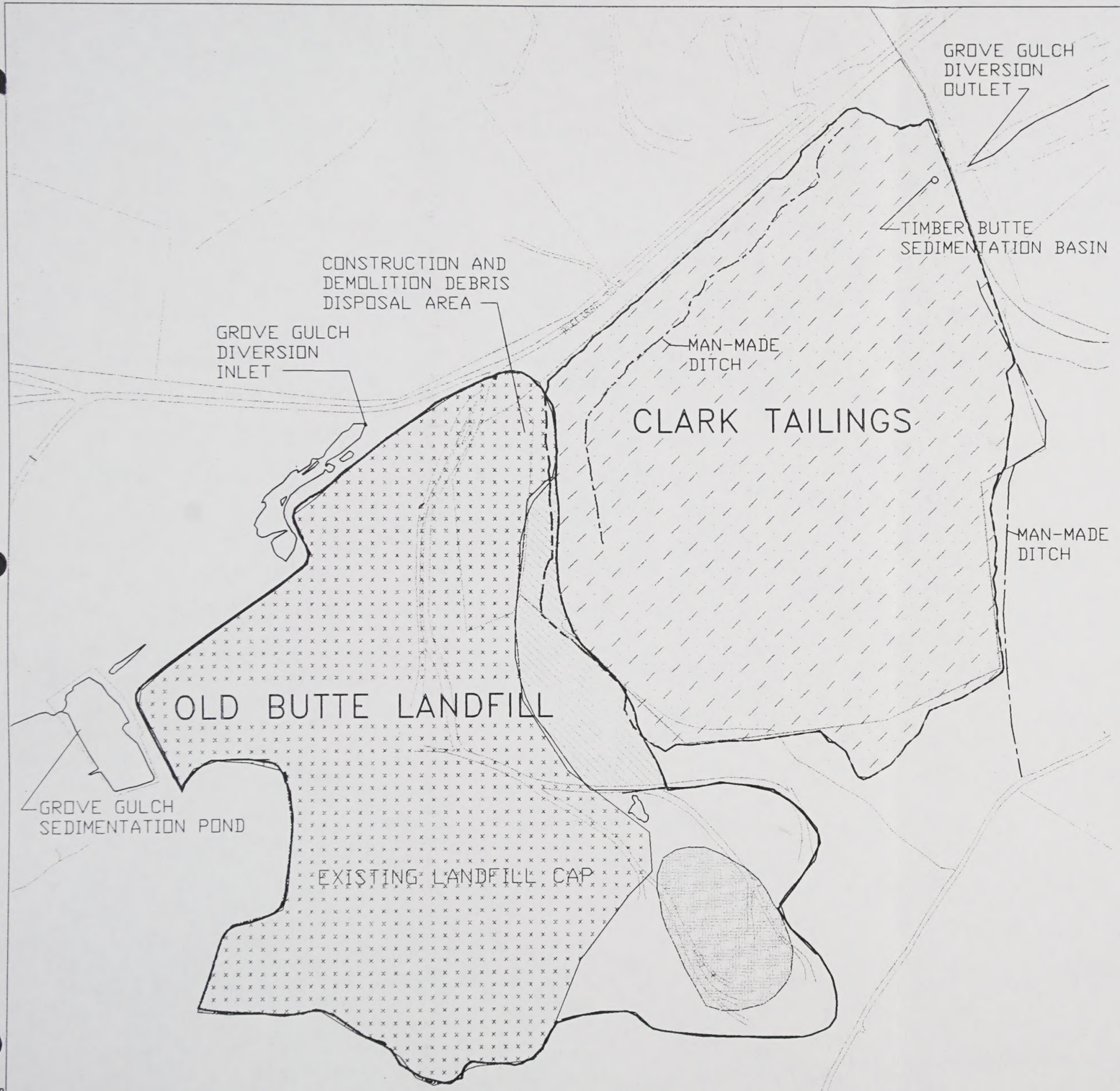


FIGURE 2-2
OLD LANDFILL/CLARK TAILINGS
APPROXIMATE CAP BOUNDARIES

NEER
AL SERVICES, INC.

SCALE: AS NOTED
DATE: 1/14/97

4502-F15



LEGEND

- FENCE
- SURFACE DRAINAGE
- EXISTING CLARK TAILINGS COVER
- AREA REQUIRING ADDITIONAL COVER FILLED PRIOR TO OCTOBER 9, 1991
- AREA REQUIRING COVER FILLED AFTER OCTOBER 9, 1991
- COMPLETED LANDFILL COVER (AS OF 12/96)
- RAILROAD
- ROAD

N

0 100 200

SCALE (meters)

FIGURE 2-2
OLD LANDFILL/CLARK TAILINGS
APPROXIMATE CAP BOUNDARIES

PIONEER TECHNICAL SERVICES, INC.

SCALE: AS NOTED
DATE: 1/14/97

4502-F15

FIGURE 2-3
GEOLOGIC
CROSS-SECTION
LOCATION

SCALE: AS NOTED
DATE: 1/97

NEER
L SERVICES, INC.

4502-F12

TRAILER COURT

CLK–1

BSB–A5

CLARK TAILINGS

BSB–A1

BSB–A6

MBMG–2

BSB–A2

APPROXIMATE CROSS–SECTION LOCATION (FIGURE 2–4)

BSB–A3

BSB–A4

OLD BUTTE LANDFILL

N

200 0 200 400 600
SCALE IN FEET

50 0 50 100 200
SCALE IN METERS

WELL

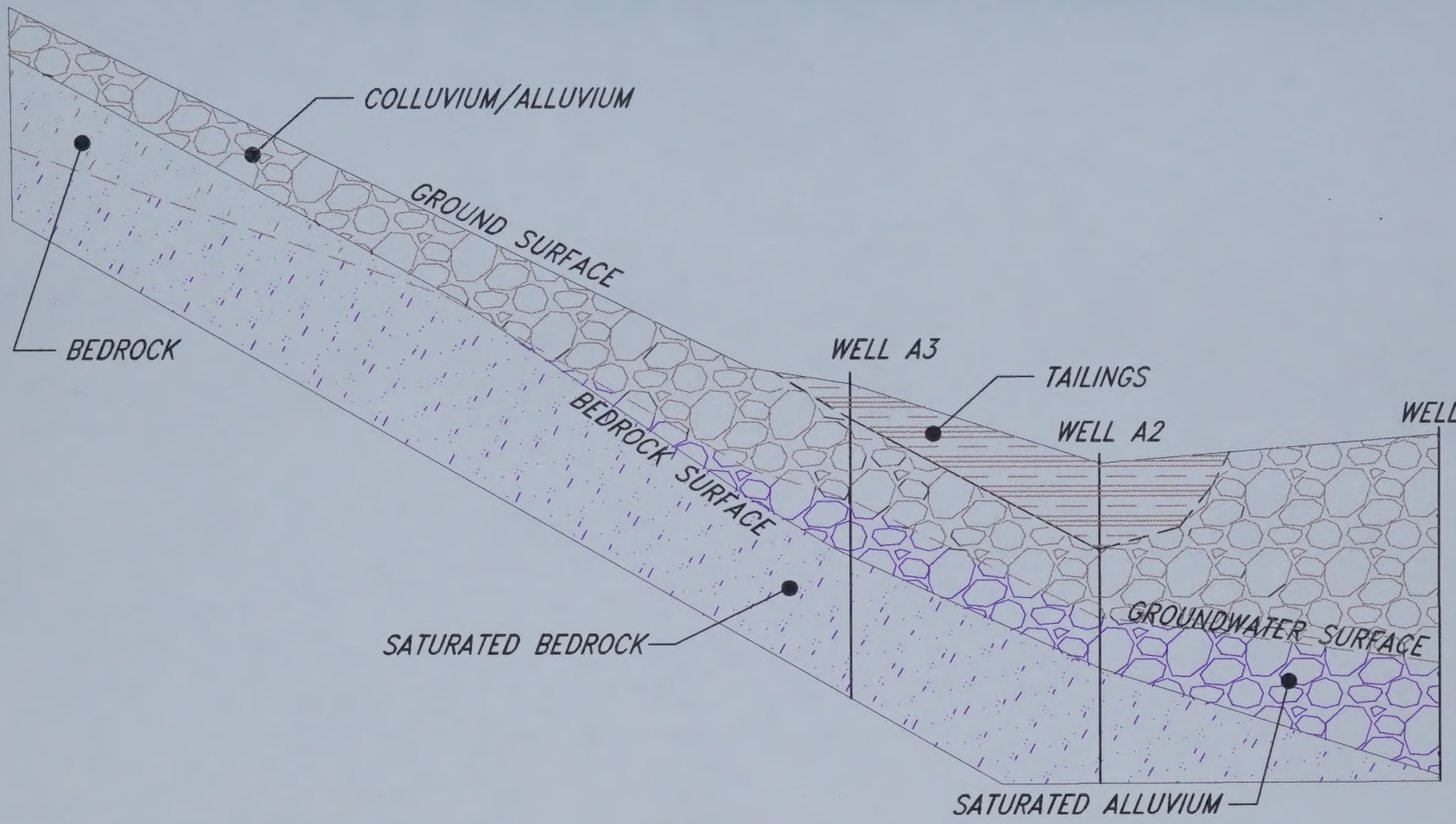
SURFACE CONTOUR

PIONEER TECHNICAL SERVICES, INC.

FIGURE 2–3
GEOLOGIC
CROSS–SECTION
LOCATION

SCALE: AS NOTED
DATE: 1/97

4503–F12



PIONEER TECHNICAL SERVICES, INC.

FIGURE 2-4
SITE GEOLOGIC
CROSS SECTION

SCALE: AS NOTED
DATE: 1/97

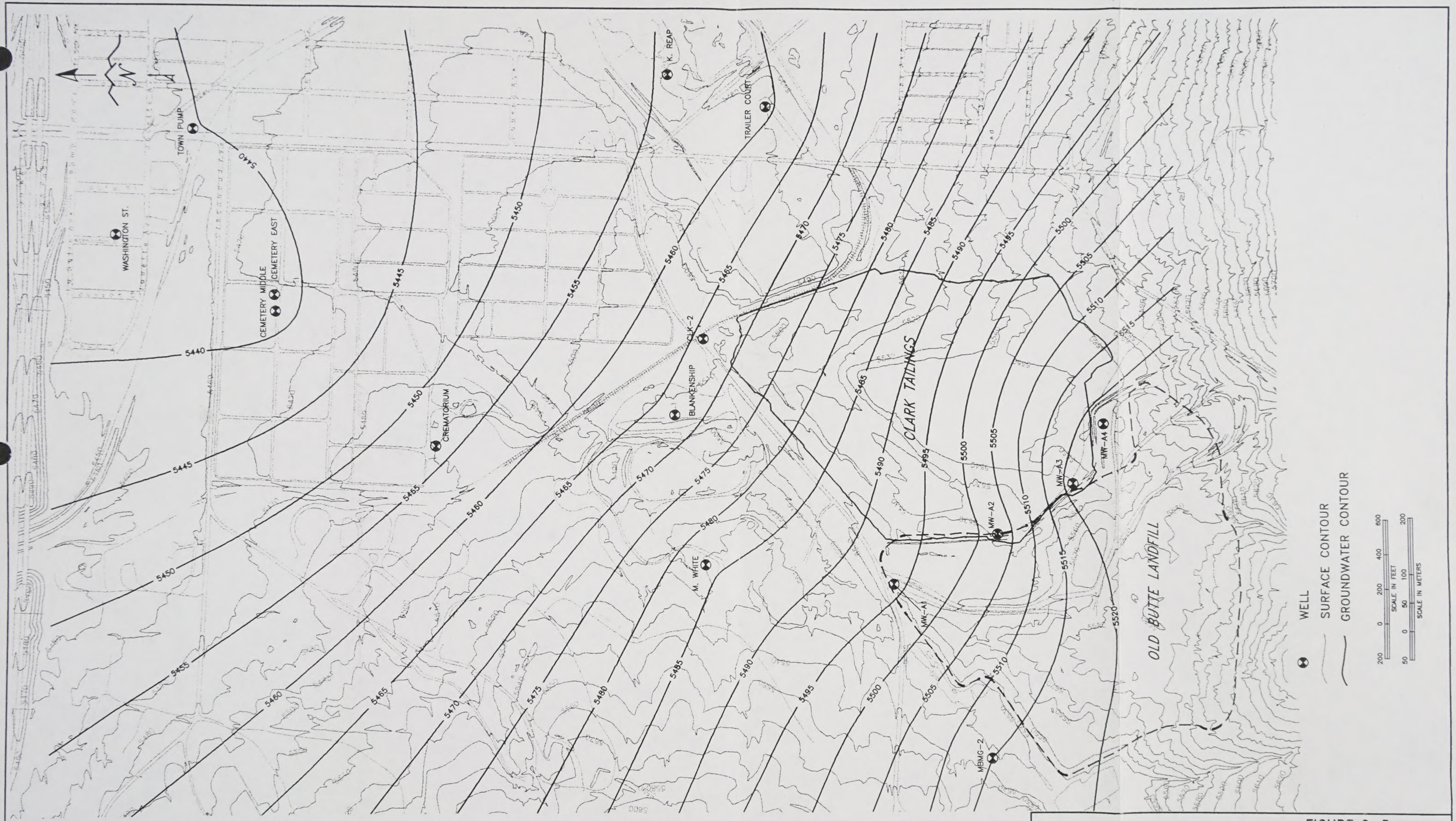
4502-F17

4502-F08

WEER SERVICES, INC.

FIGURE 2-5
GROUNDWATER CONTOURS
MARCH 1995

SCALE: AS NOTED
DATE: 1/97

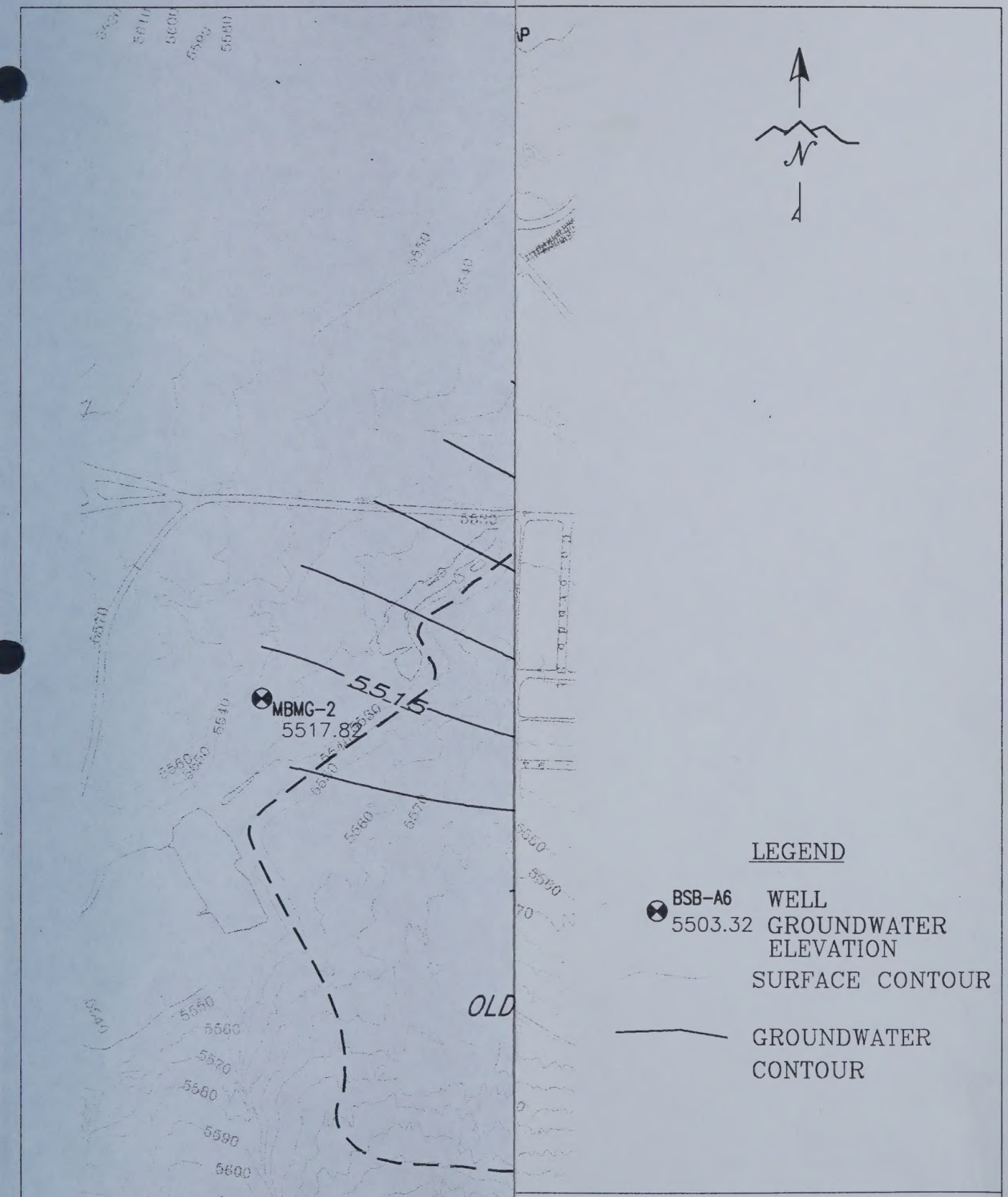


PIONEER TECHNICAL SERVICES, INC.

FIGURE 2-5
GROUNDWATER CONTOURS
MARCH 1995

SCALE: AS NOTED
DATE: 1/97

4502-F08



LEGEND

BSB-A6 WELL
5503.32 GROUNDWATER ELEVATION

SURFACE CONTOUR

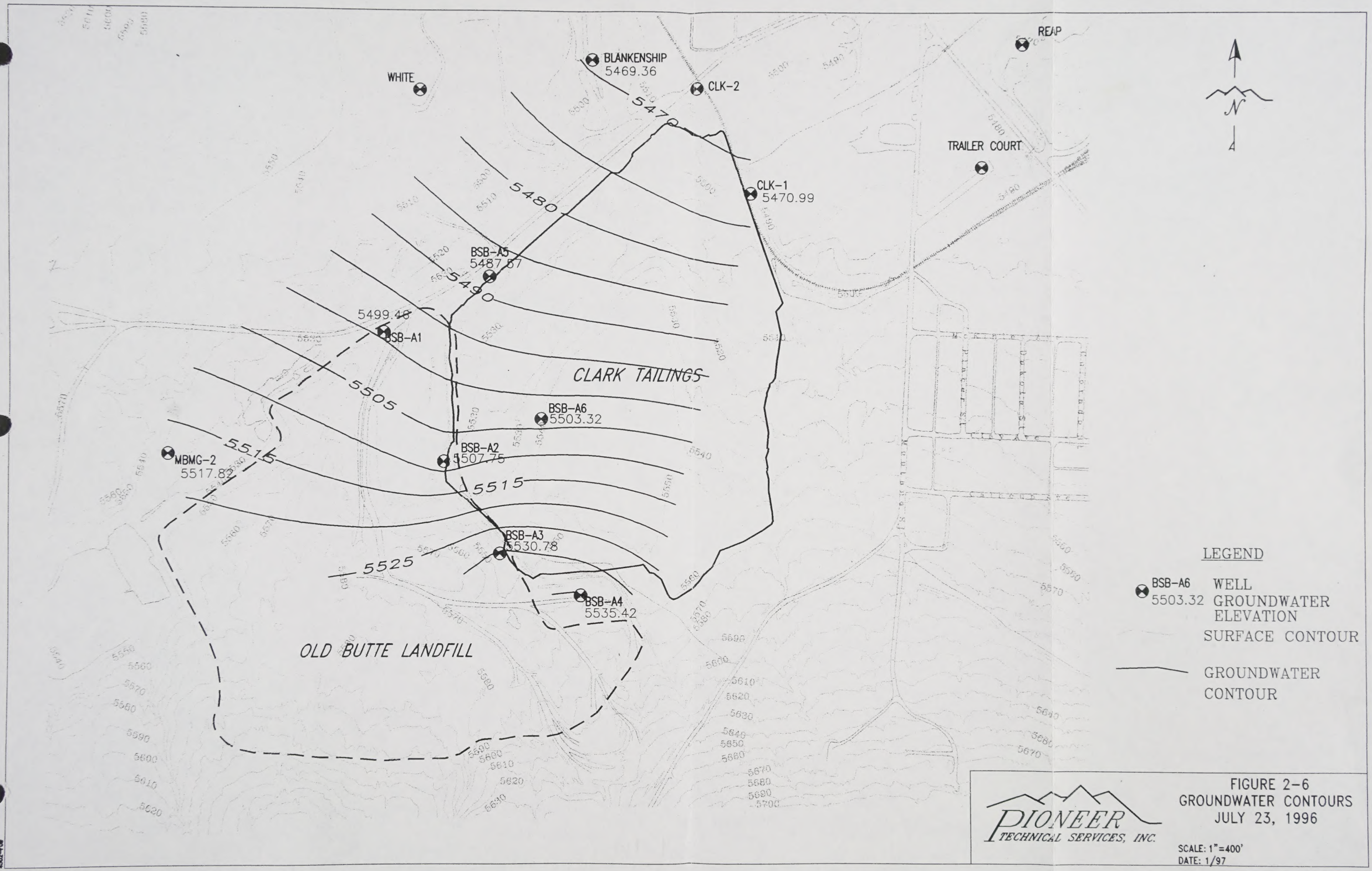
GROUNDWATER CONTOUR

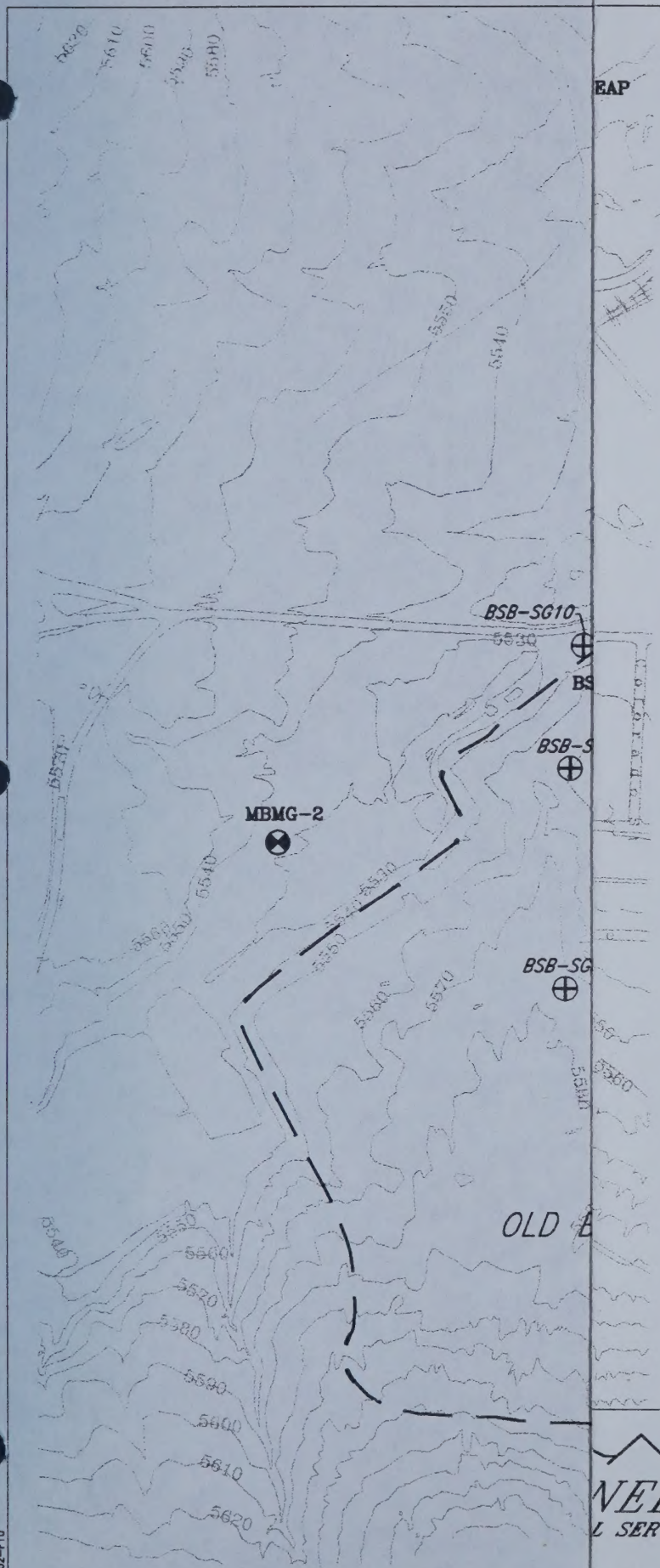
FIGURE 2-6
GROUNDWATER CONTOURS
JULY 23, 1996

SCALE: 1"=400'
DATE: 1/97

NEER
L SERVICES, INC.

4502-F09


BLANKENSHIP
5469.36
WHITE
CLK-2
REAP
TRAILER COURT
CLK-1
5470.99
5470
5480
5490
5505
5515
5525
BSB-A5
5487.67
5499.48
BSB-A1
CLARK TAILINGS
BSB-A6
5503.32
BSB-A2
5507.75
MBMG-2
5517.82
BSB-A3
5530.78
BSB-A4
5535.42
OLD BUTTE LANDFILL
N
LEGEND
BSB-A6 5503.32 WELL GROUNDWATER ELEVATION
SURFACE CONTOUR
GROUNDWATER CONTOUR
PIONEER TECHNICAL SERVICES, INC.
FIGURE 2-6
GROUNDWATER CONTOURS
JULY 23, 1996
SCALE: 1"=400'
DATE: 1/97
4502-F09



LEGEND

⊗ EXISTING GROUNDWATER MONITORING WELL

SURFACE CONTOUR

⊕ GEOPROBE SAMPLING POINT (SOIL GAS, SOIL, AND/OR GROUNDWATER)

N

200 0 200 400 600
SCALE IN FEET

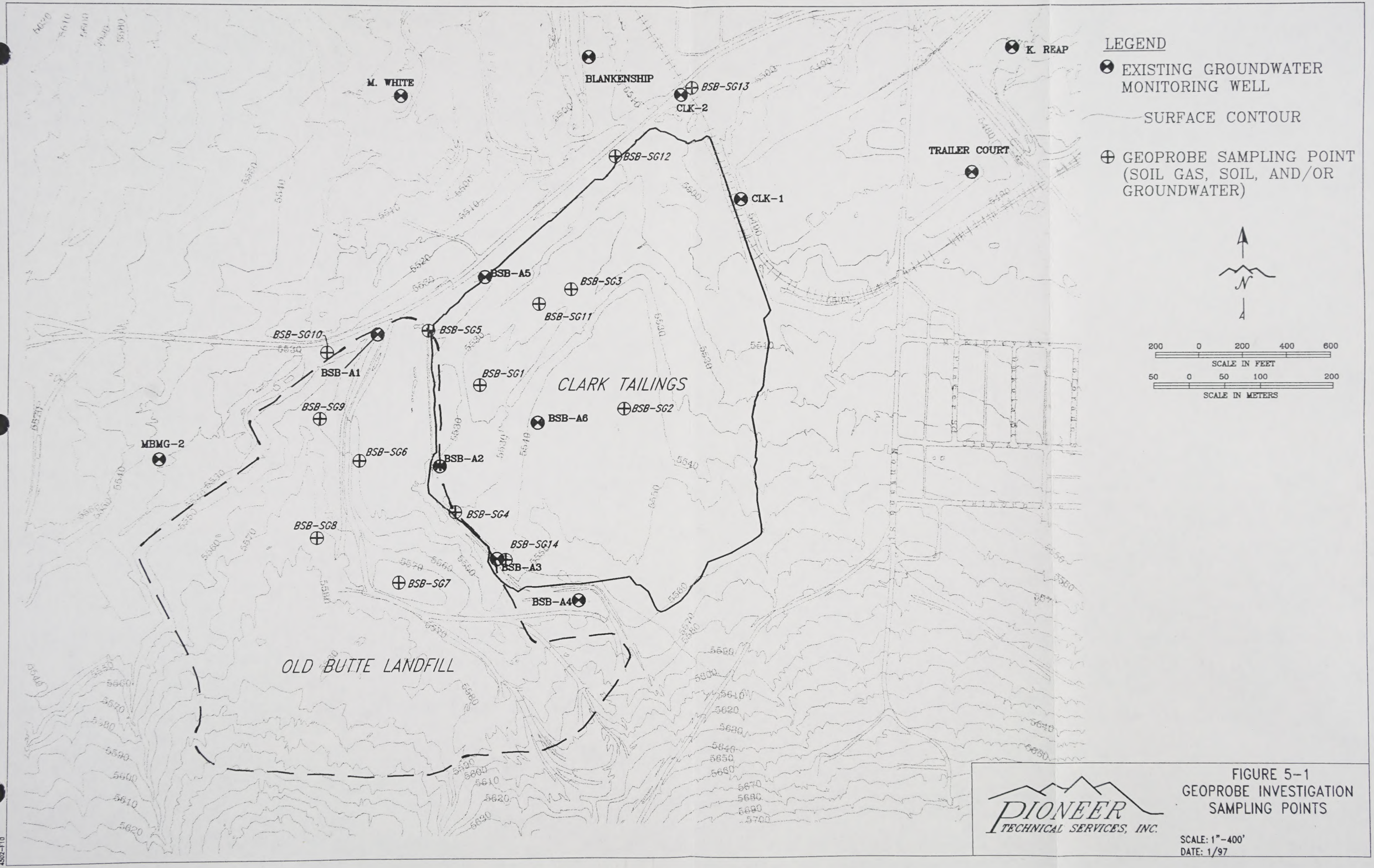
50 0 50 100 200
SCALE IN METERS

NEER
L SERVICES, INC.

FIGURE 5-1
GEOPROBE INVESTIGATION
SAMPLING POINTS

SCALE: 1"-400'
DATE: 1/97

4502-F10

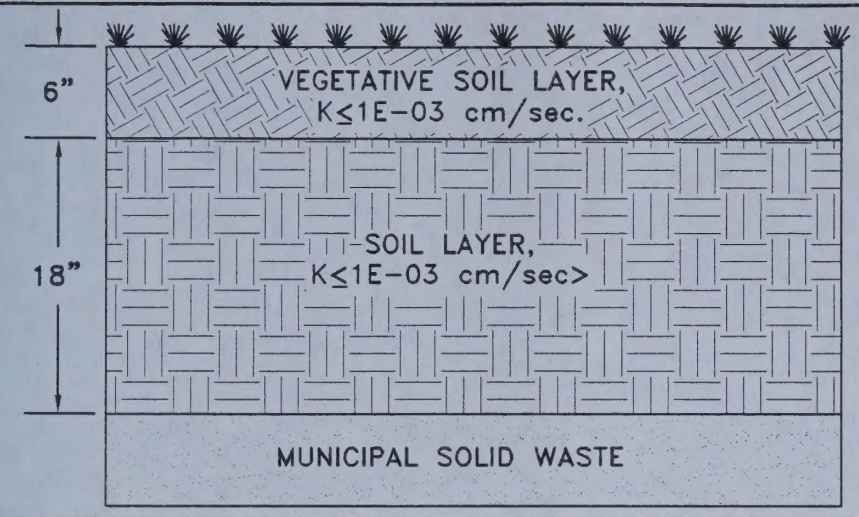


PIONEER TECHNICAL SERVICES, INC.

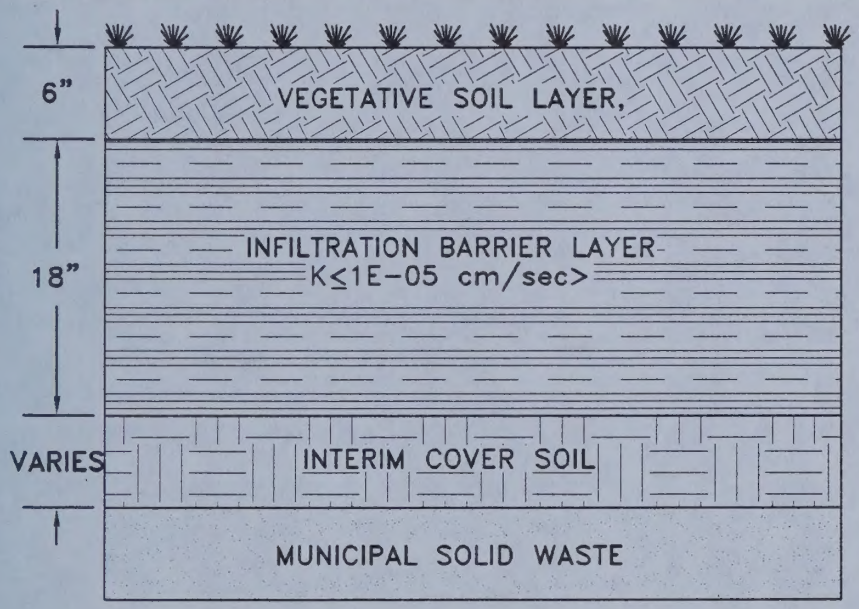
FIGURE 5-1
GEOPROBE INVESTIGATION SAMPLING POINTS

SCALE: 1"=400'
DATE: 1/97

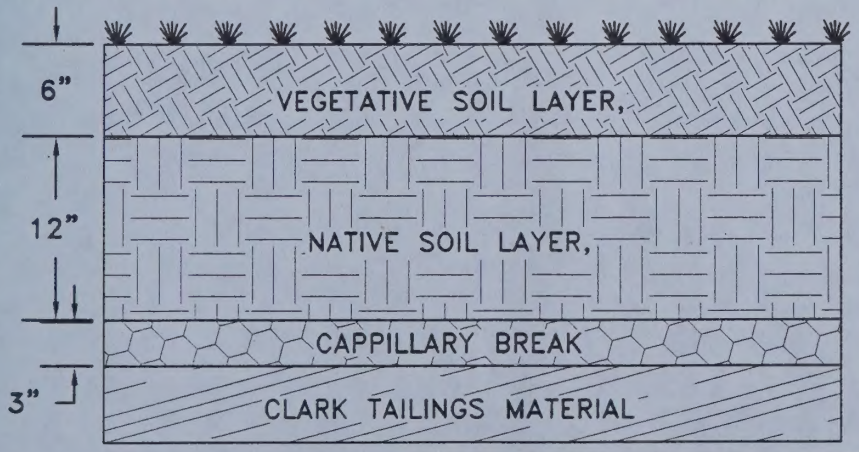
4502-F10



LANDFILL CAP FOR AREAS WHICH STOPPED RECEIVING WASTE PRIOR TO OCTOBER 9, 1991.



LANDFILL CAP FOR AREAS WHICH RECEIVED WASTE AFTER OCTOBER 9, 1991.



CLARK TAILINGS CAP

PIONEER TECHNICAL SERVICES, INC.

FIGURE 6-1
NATIVE MATERIALS CAP
CROSS SECTIONS

SCALE: 1" = 1'
DATE: 12/20/96

4502-F02

VEGETATIVE SOIL LAYER
MUNICIPAL SOLID WASTE

VEGETATIVE SOIL LAYER
MUNICIPAL SOLID WASTE

VEGETATIVE SOIL LAYER
NATIVE SOIL LAYER
CLAYEY TAILINGS MATERIAL

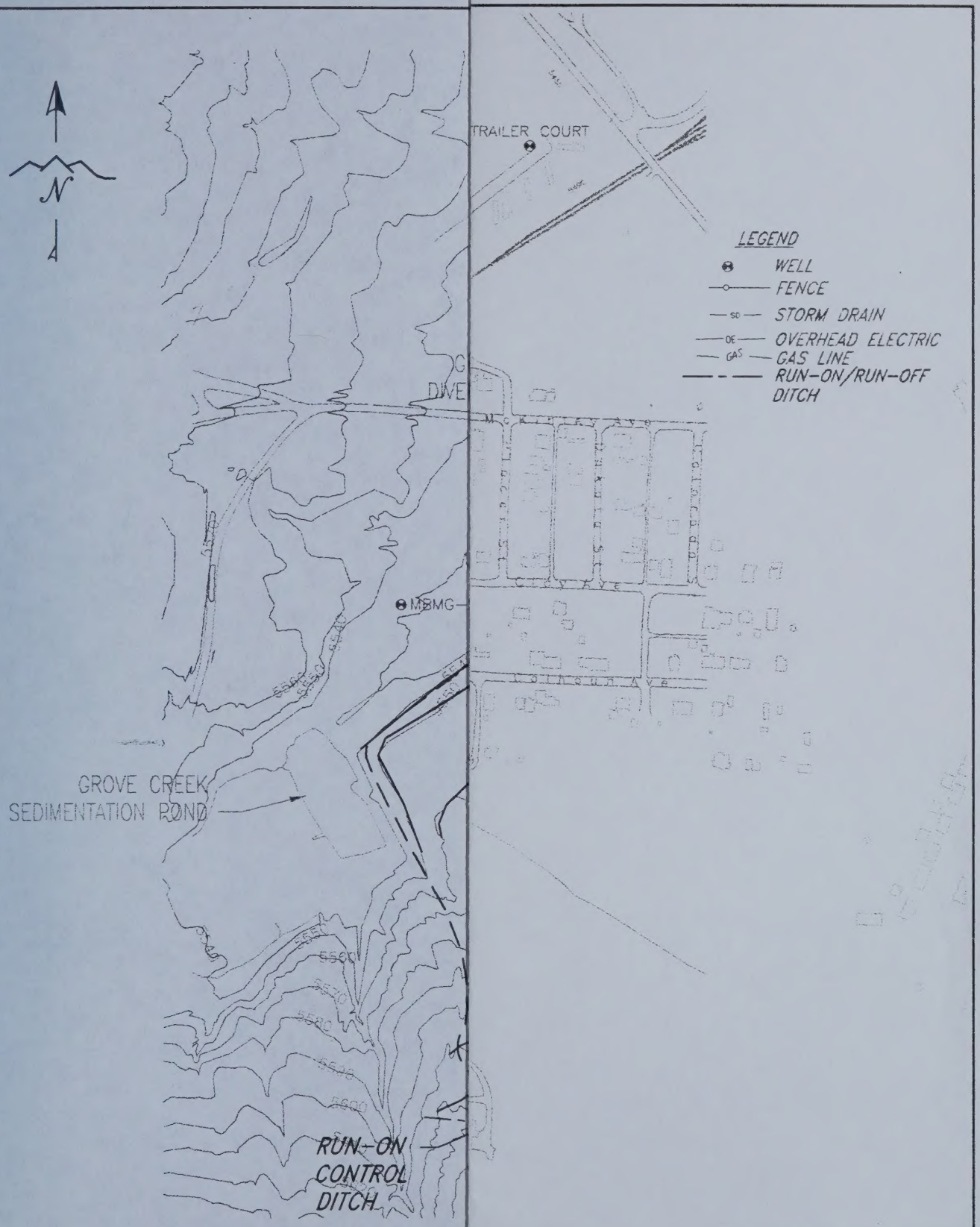
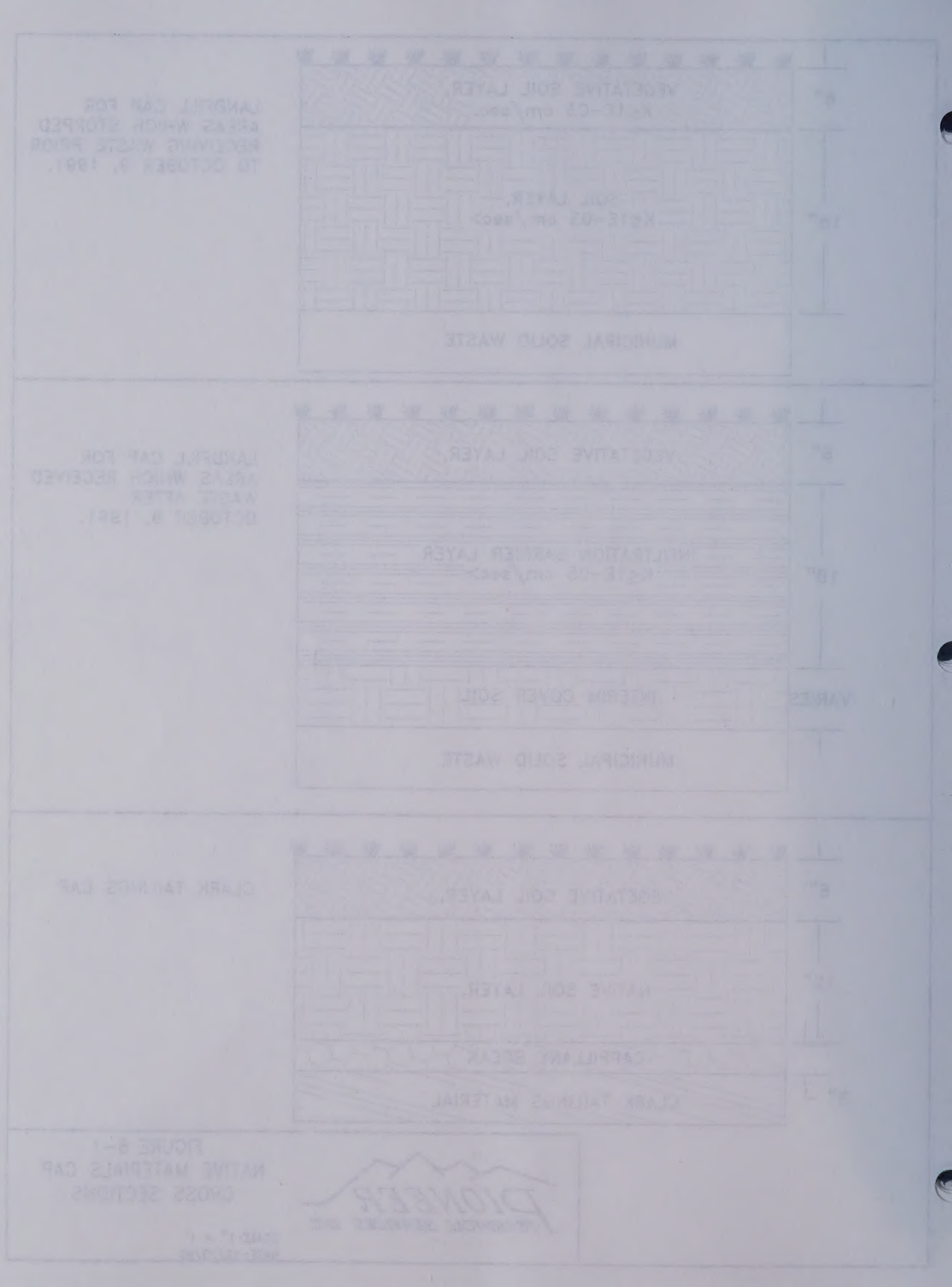


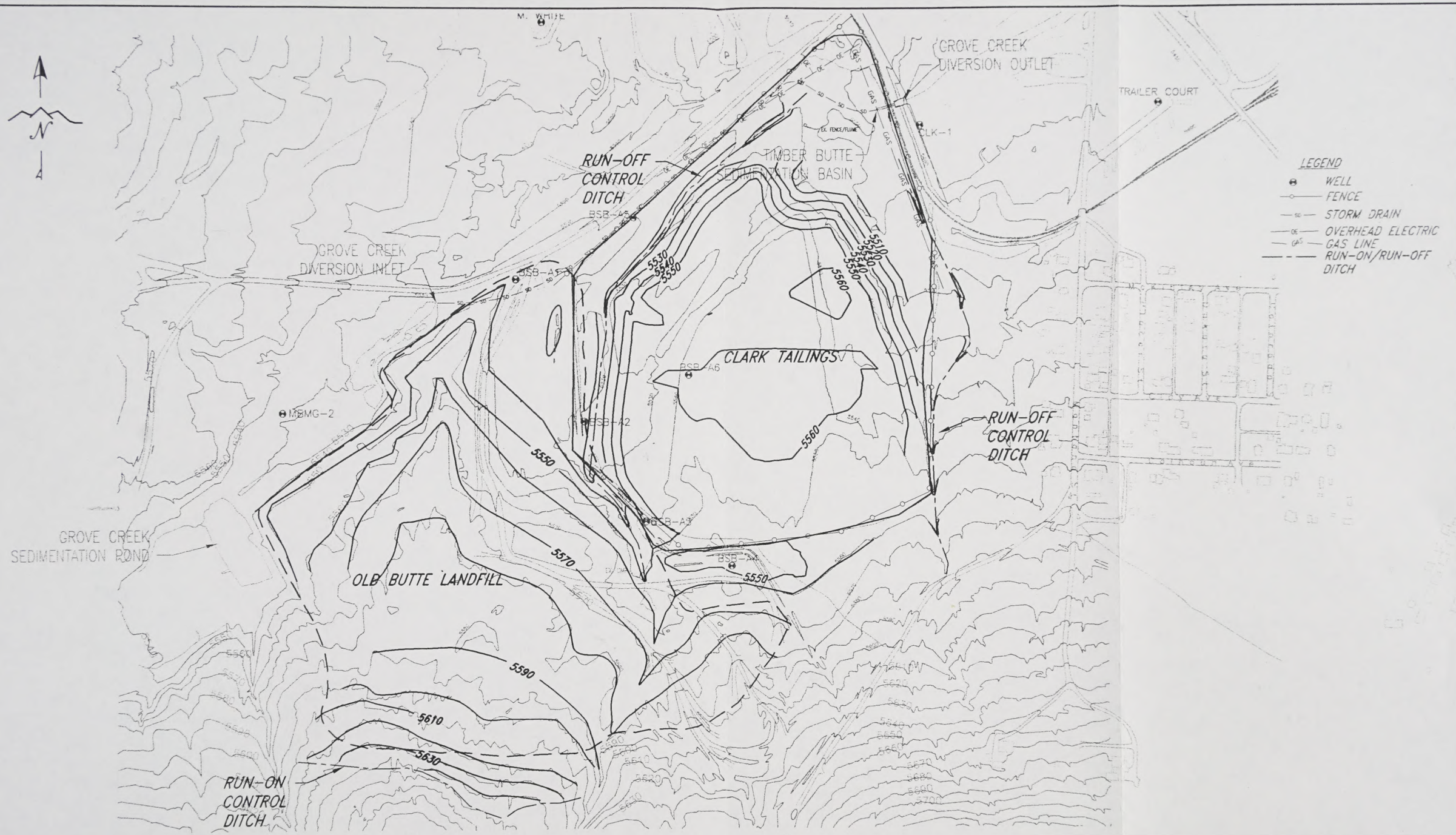
FIGURE 6-2
OLD LANDFILL/
CLARK TAILINGS
FINAL GRADING PLAN

SCALE: 1"=400'
DATE: 1/97

NEER
L SERVICES, INC.

4502-F14

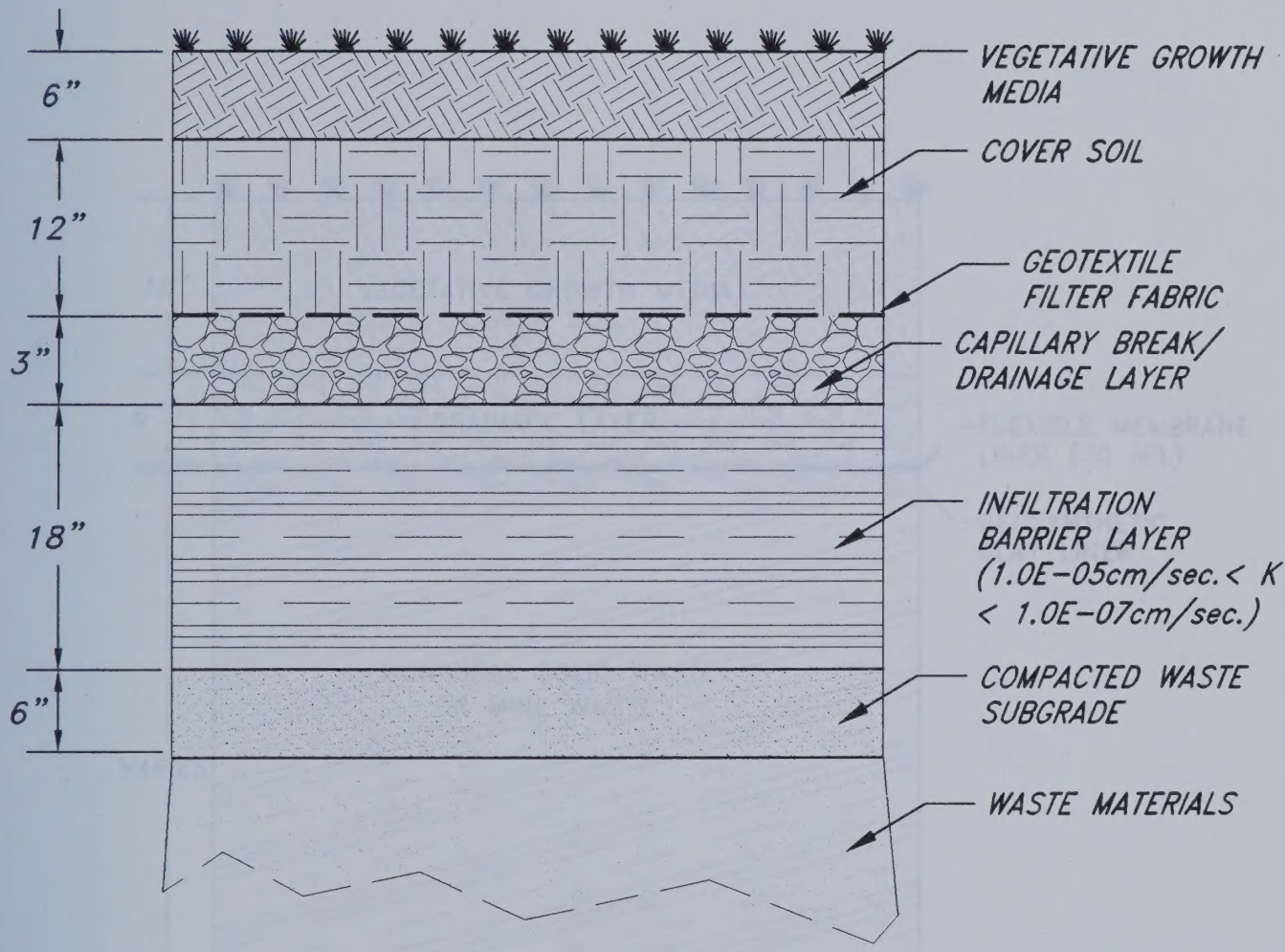




PIONEER TECHNICAL SERVICES, INC.

FIGURE 6-2
OLD LANDFILL/
CLARK TAILINGS
FINAL GRADING PLAN
SCALE: 1"=400'
DATE: 1/97

4502-F14

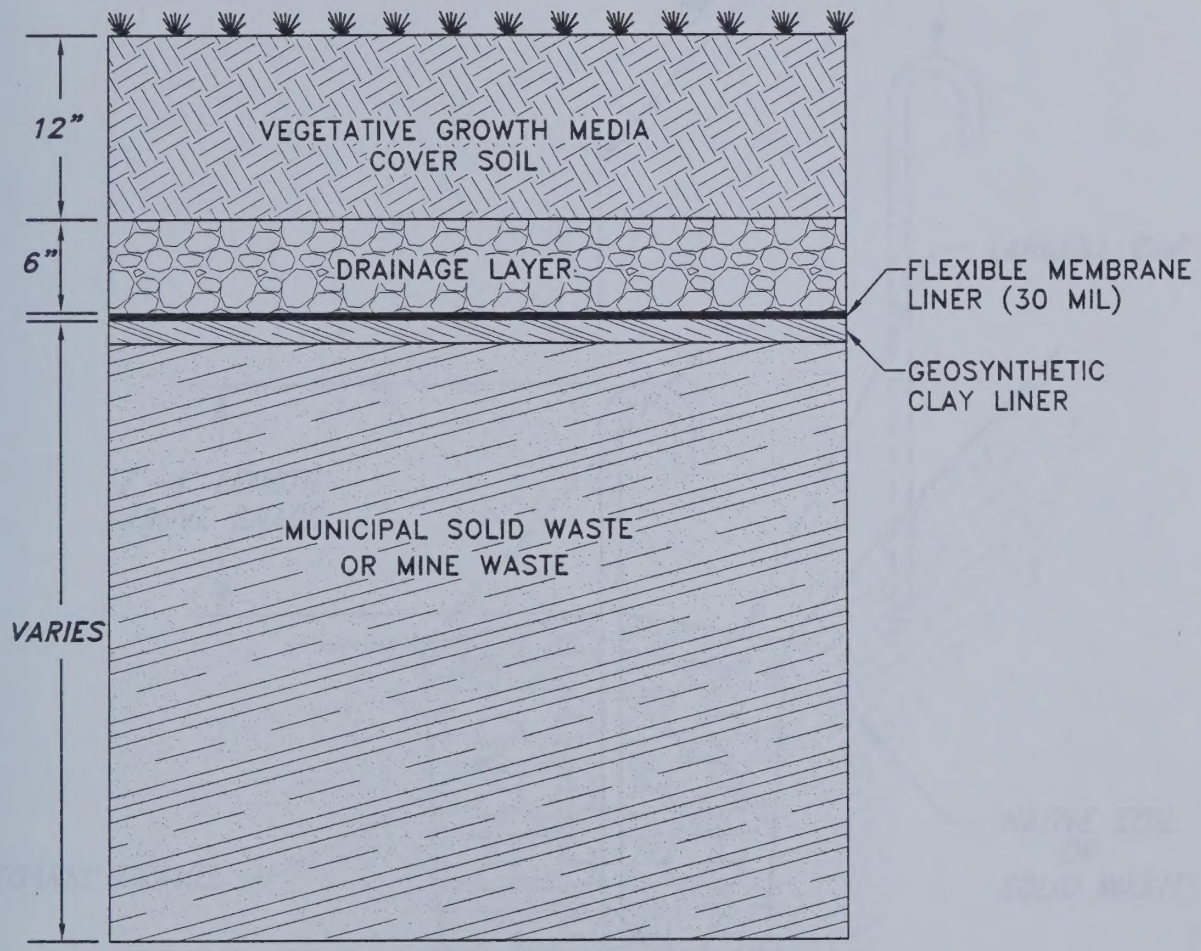


PIONEER TECHNICAL SERVICES, INC.

FIGURE 6-3
ALTERNATIVE 5
CLARK TAILINGS CAP

SCALE: N/A
DATE: 2/3/97

4502-F01

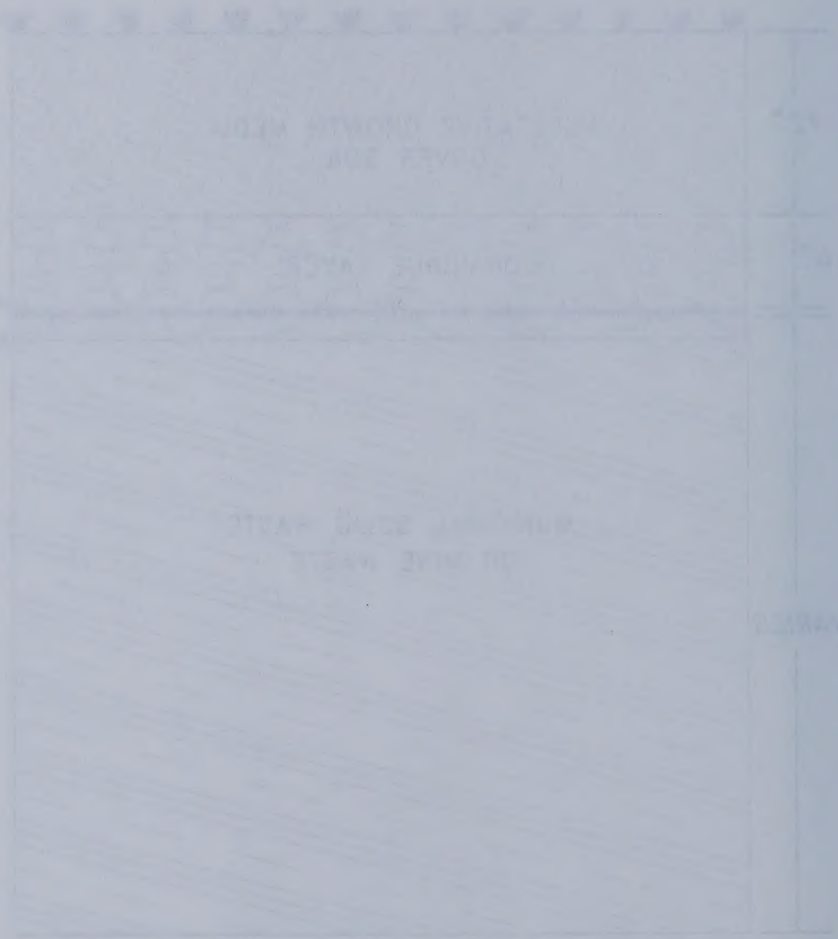


PIONEER
TECHNICAL SERVICES, INC.

FIGURE 6-4
ALTERNATIVE 6
MULTIMEDIA CAP

SCALE: 1" = 1'
DATE: 12/20/96

4502-F03



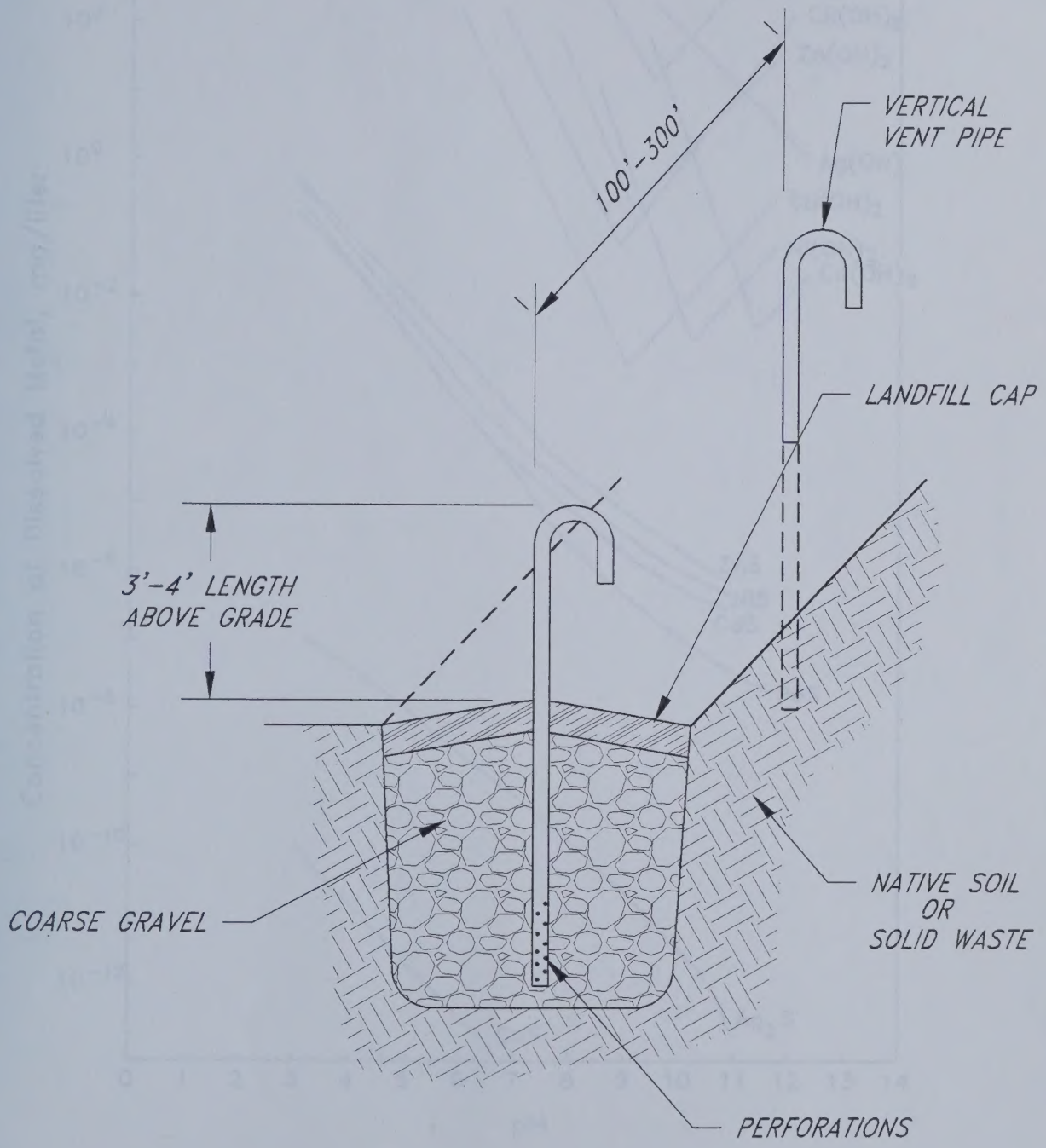
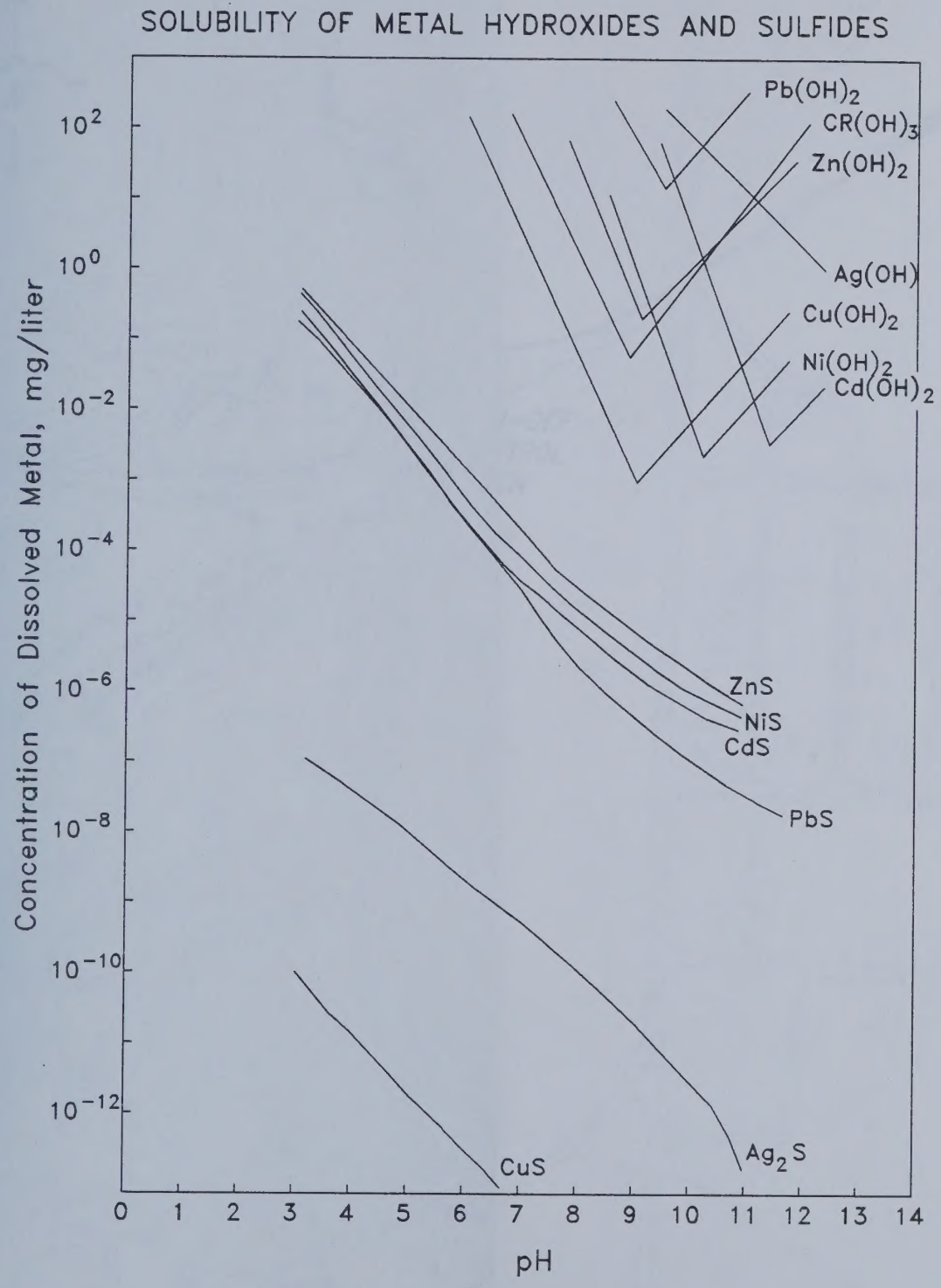


FIGURE 6-5
PASSIVE GAS VENT

PIONEER
TECHNICAL SERVICES, INC.

SCALE: N/A
DATE: 1/13/97

4502-F13



Source: EPA, 1987

PIONEER TECHNICAL SERVICES, INC.

FIGURE 6-6
SOLUBILITY OF METAL HYDROXIDES AND SULFIDES

SCALE: N/A
DATE: 12/12/96

4502-F04

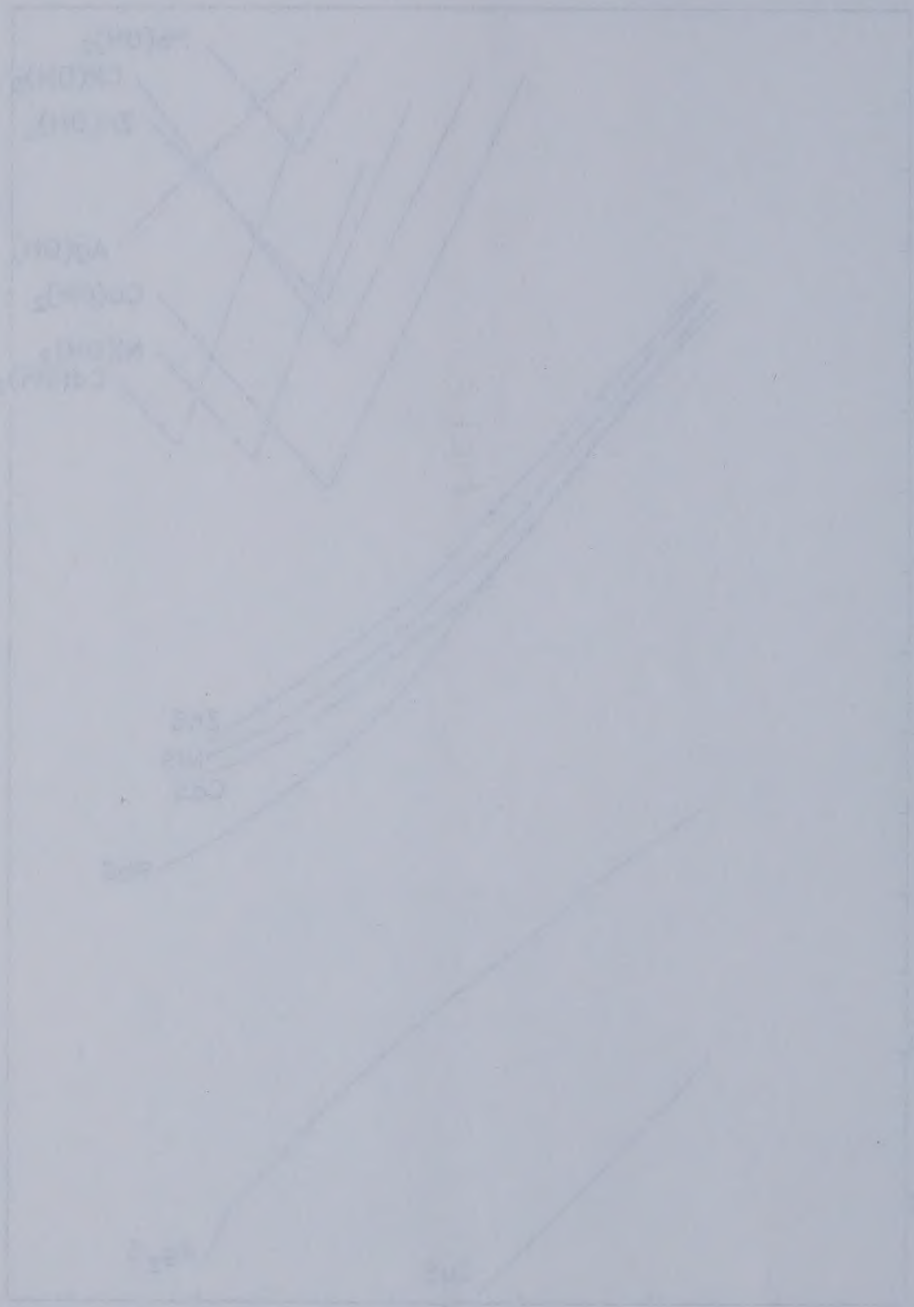
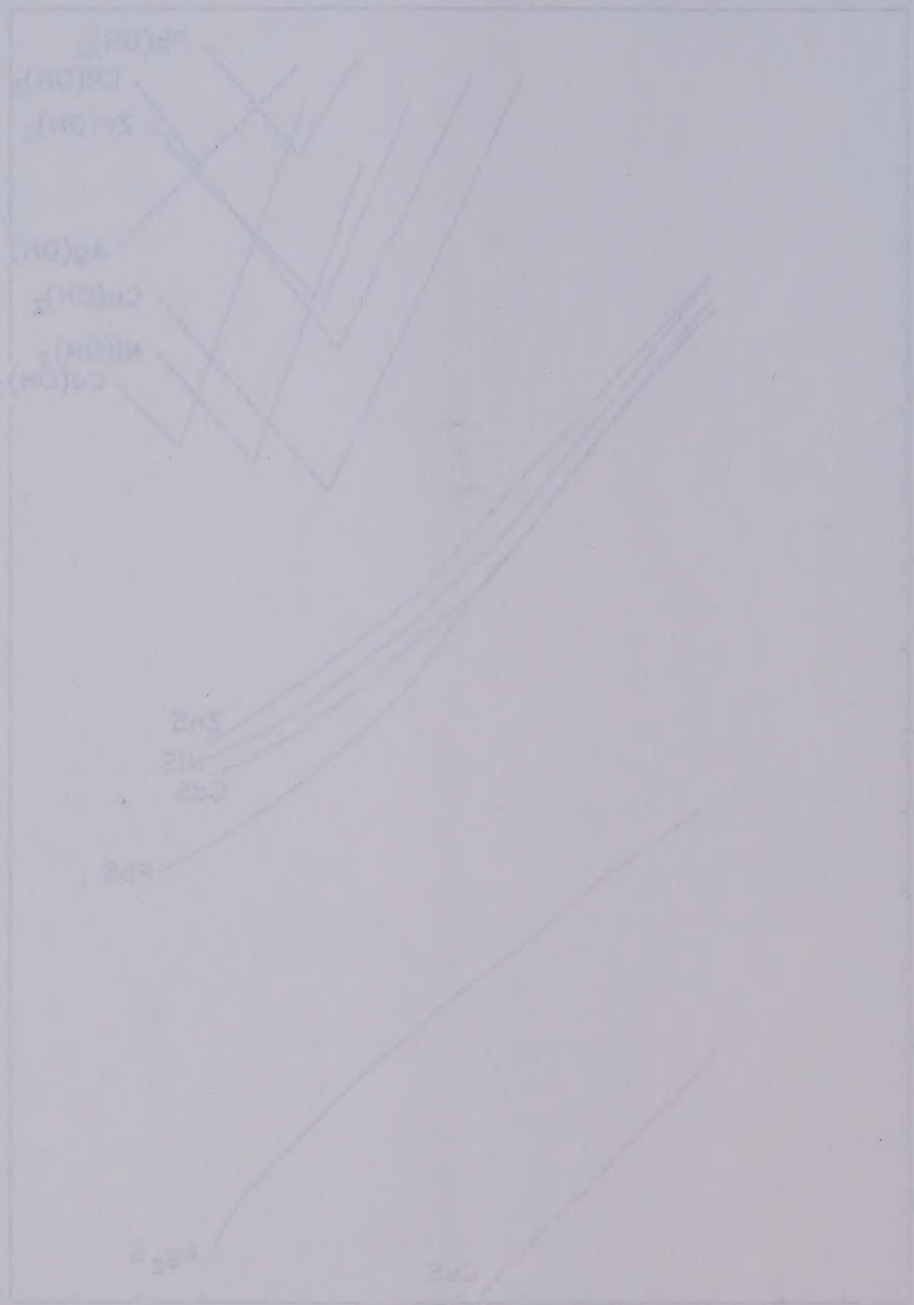
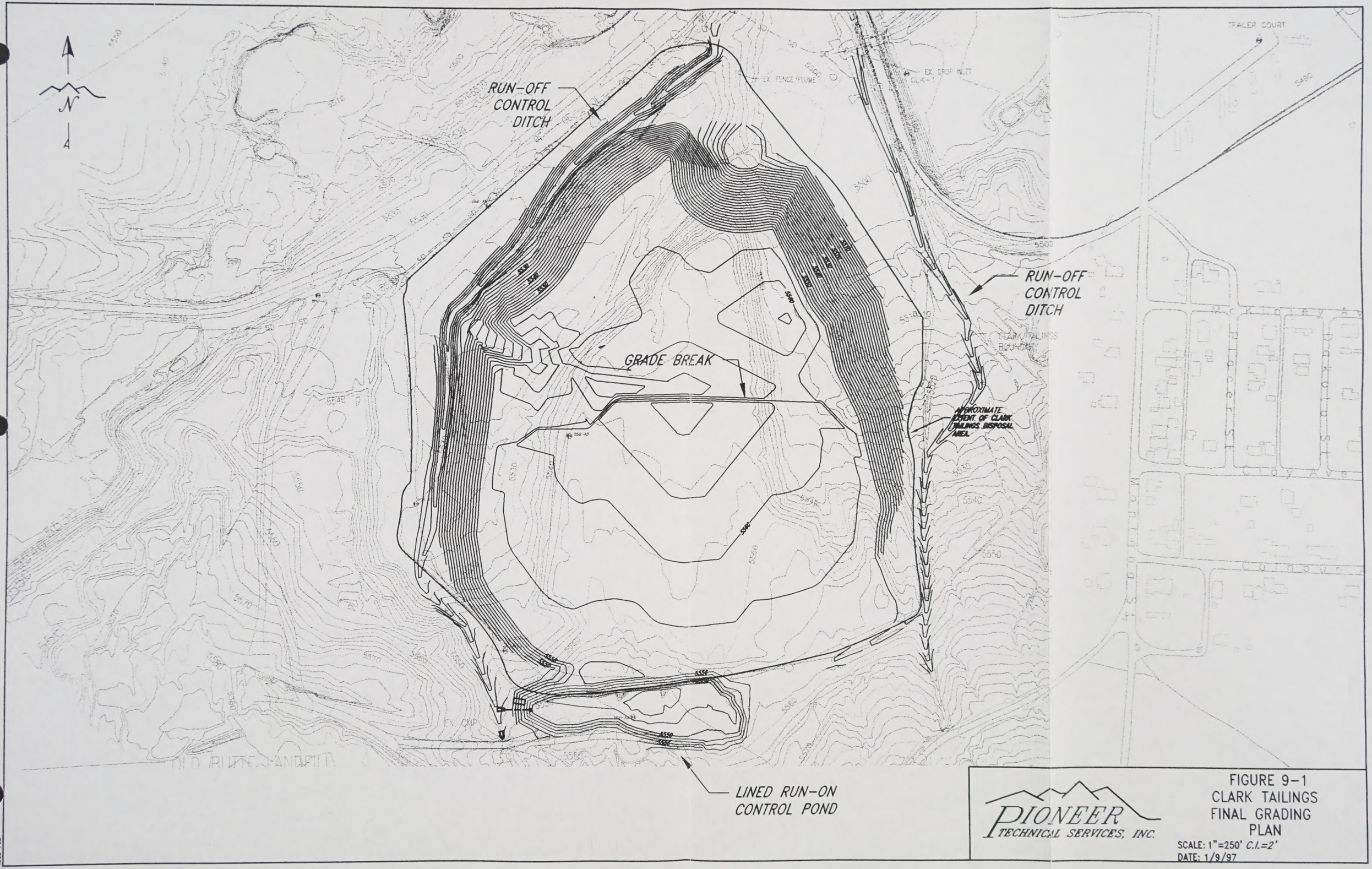


FIGURE 9-1
CLARK TAILINGS
FINAL GRADING
PLAN

SCALE: 1"=250' C.I.=2'
DATE: 1/9/97

4502-T05





PIONEER TECHNICAL SERVICES, INC.

FIGURE 9-1
CLARK TAILINGS
FINAL GRADING
PLAN

SCALE: 1"=250' C.I.=2'
DATE: 1/9/97

4502-F05

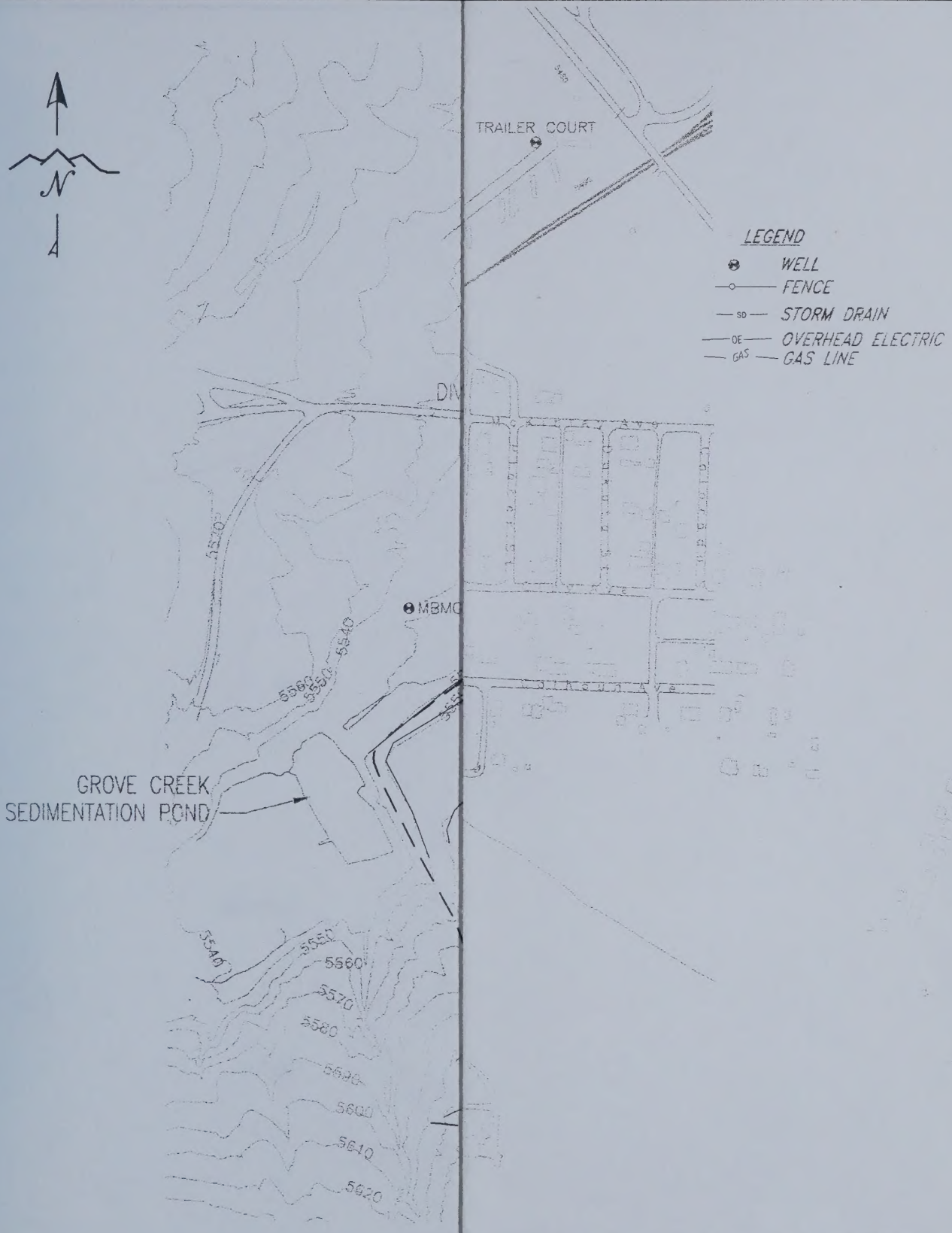


FIGURE 9-2
LANDFILL GAS
VENTING SCHEMATIC

SCALE: 1"=400'
DATE: 1/97

4502-F16

N

M. WHITE

GROVE CREEK DIVERSION OUTLET

TRAILER COURT

CLK-1

EX. FENCE/FLUME

TIMBER BUTTE SEDIMENTATION BASIN

BSB-A5

GROVE CREEK DIVERSION INLET

BSB-A1

GAS VENT (TYP)

CLARK TAILINGS

BSB-A6

MBMG-2

BSB-A2

GAS COLLECTION TRENCH

BSB-A3

BSB-A4

GROVE CREEK SEDIMENTATION POND

OLD BUTTE LANDFILL

5510 5520 5530 5540 5550 5560 5570 5590 5610 5630

LEGEND

- WELL
- FENCE
- SD — STORM DRAIN
- OE — OVERHEAD ELECTRIC
- GAS — GAS LINE

PIONEER TECHNICAL SERVICES, INC.

FIGURE 9-2
LANDFILL GAS
VENTING SCHEMATIC

SCALE: 1"=400'
DATE: 1/97

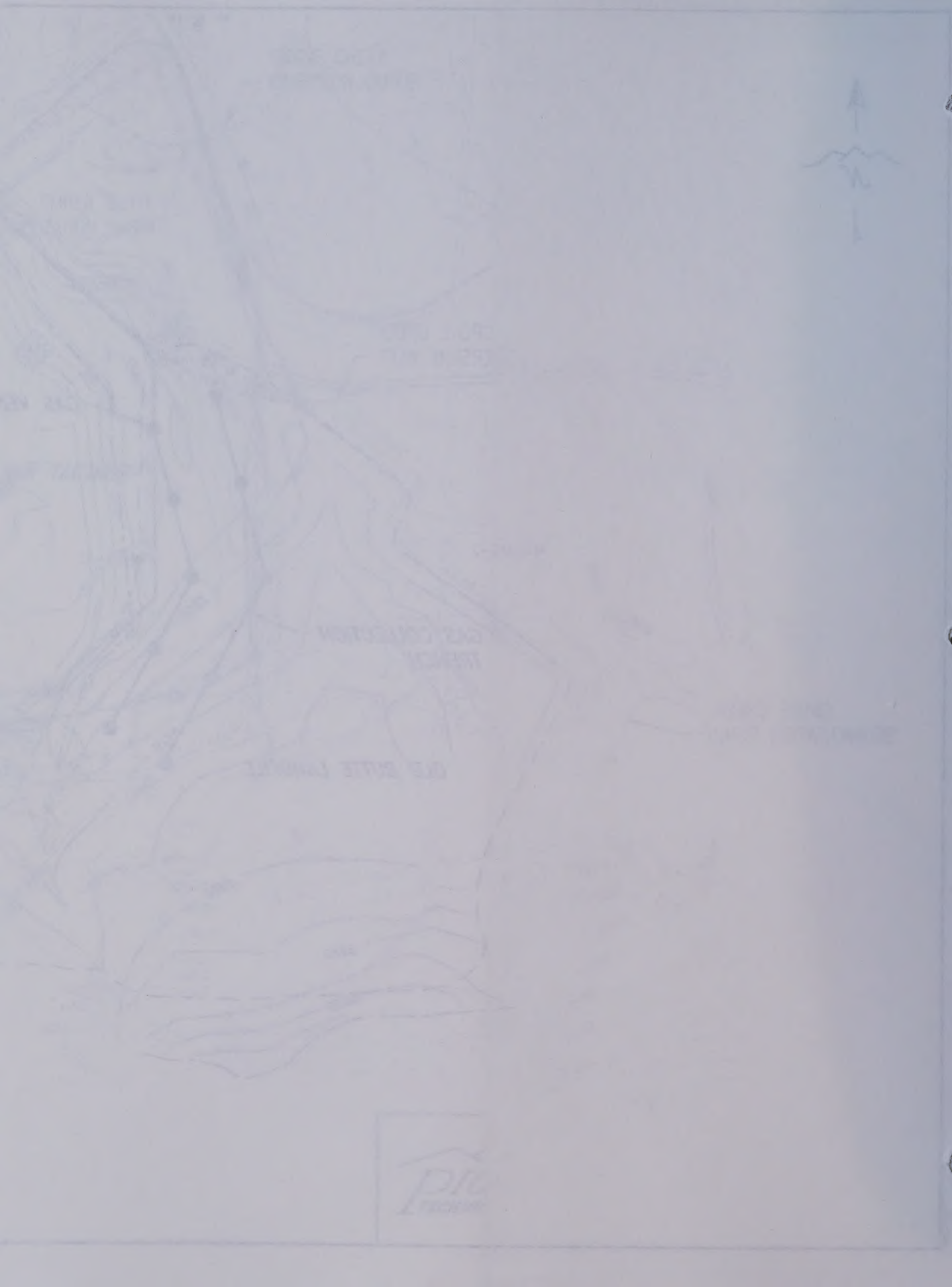
4502-F18

FIGURE 9-3
RECREATION COMPLEX
SCHEMATIC LAYOUT

NEER
AL SERVICES, INC.

SCALE: 1"=200'
DATE: 1/9/97

4502-F06



BEEFTRAIL ROAD

AMPHITHEATER

5520
5530
5540
5550

5560

PICNIC AREAS

MIGHTY MITE FIELDS

PICNIC AREAS

PARKING
300 CARS

5510

5520

5530

5540

5550

GOLF

DRIVING

RANGE

1

2

3

4

5

6

BABE RUTH FIELDS

SOFTBALL FIELDS

& AMERICAN LEGION

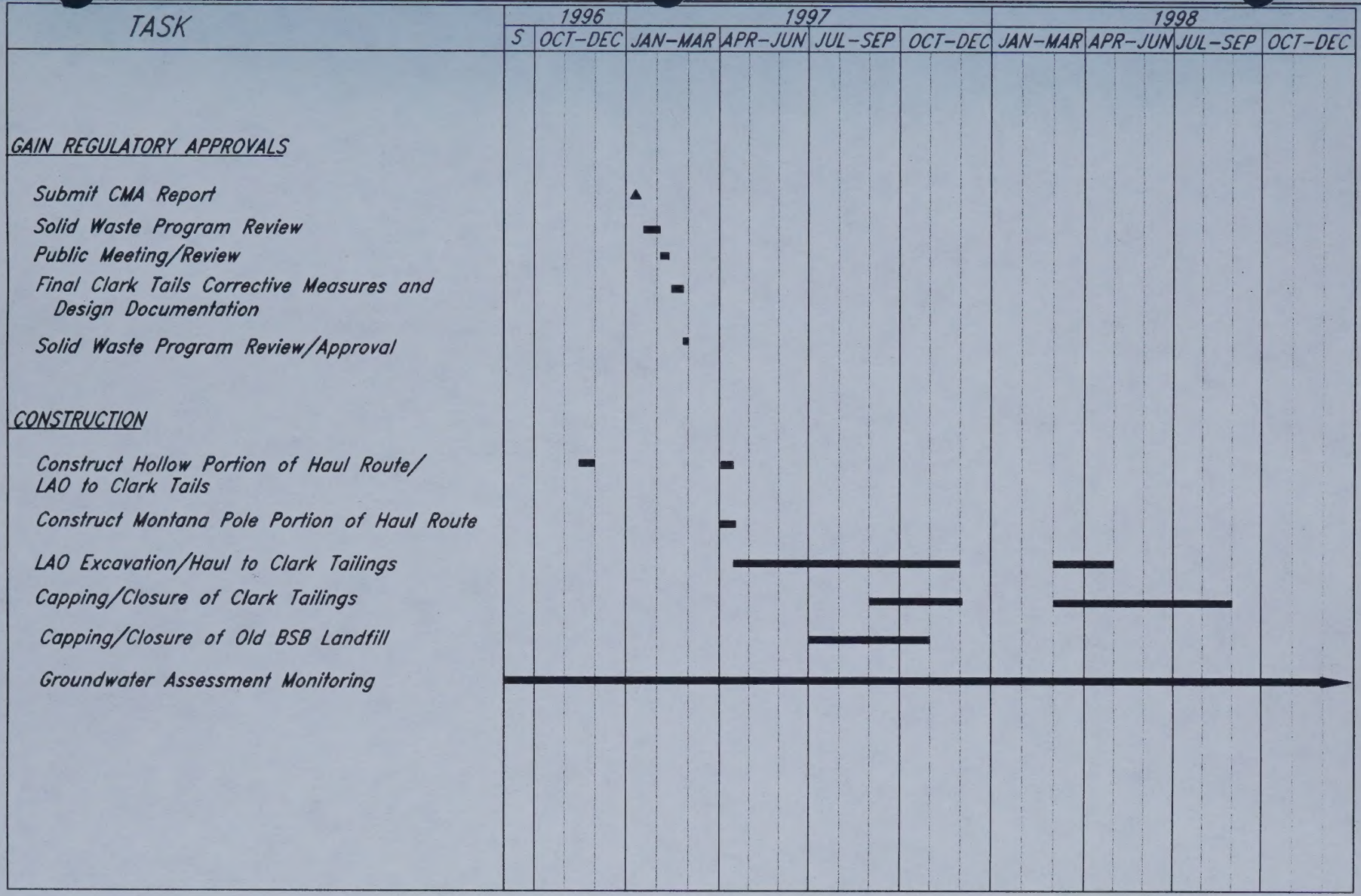
MONTANA ST.

PIONEER
TECHNICAL SERVICES, INC.

FIGURE 9-3
RECREATION COMPLEX
SCHEMATIC LAYOUT

SCALE: 1"=200'
DATE: 1/9/97

4502-F06



PIONEER TECHNICAL SERVICES, INC.

FIGURE 11-1
OLD LANDFILL/
CLARK TAILINGS
PROJECT SCHEDULE

SCALE: N/A
DATE: 1/97

A502-F11

TABLE 2-1: ESTIMATED FLOOD FLOWS IN GROVE GULCH

RETURN FREQUENCY (years)	FLOW (cubic feet per second)
2	17.7
10	81.9
25	149
50	212
100	293

TABLE 5-1

OLD SILVER BOW LANDFILL GROUNDWATER DATA STATISTICAL SUMMARY
INORGANIC CONSTITUENTS (ug/L)
(updated 10/11/96)

	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		BSB-A5		BSB-A6		Mean Exceeds	Median Exceeds	BLANK		LAB
	USEPA MCL*	MT HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Std. or Bkd.	Std. or Bkd.	Mean	Median	MDL
			n=6		n=8		n=8		n=8		n=7		n=4		n=4				n=6		
Ag	100(s)	--	0.1	0.1	0.8	0.1	10.7	0.1	2.4	0.1	0.1	0.1	0.1	0.1	14.5	11.0	None	None	1.6	0.1	0.21
As	50	18	3	2	2	2	10	12	38	41	3	3	3	2	11	11	None	None	1	1	1.2
Ba	2,000	1,000	133	135	88	79	63	75	209	184	34	31	26	27	51	55	None	None	3	2	3
Be	4	40	0.8	0.8	0.5	0.6	1.1	0.8	0.5	0.5	0.6	0.8	0.2	0.1	0.4	0.3	None	None	0.3	0.1	0.1
Cd	5	5	0.2	0.1	0.2	0.2	**46.4**	**16.6**	0.1	0.0	0.1	0.0	0.0	0.0	**41.0**	**29.7**	A2,A6 (std)	A2,A6 (std)	0.03	0.03	0.054
Co	--	--	4	4	4	4	**40**	**20**	6	4	4	4	4	4	**85**	**80**	A2,A6 (bkd)	A2,A6 (bkd)	4	4	8.5
Cr	100	100	6	4	5	4	13	4	6	4	5	4	4	4	28	29	None	None	5	4	8
Cu	1,300(a)	1,000	3	2	2	2	13	2	2	2	3	2	2	2	2	2	None	None	2	2	3.3
Fe	300(s)	300	226	87	25	22	**23,310**	**8,510**	**78,510**	**81,550**	19	9	36	36	**2,623**	**2,950**	A2,3,6 (std)	A2,3,6 (std)	14	9	18
Hg	2	0.14	0.08	0.05	0.09	0.05	0.07	0.05	0.12	0.07	0.13	0.05	0.10	0.07	0.07	0.07	None	None	0.05	0.05	0.097
Ni	100	100	7	7	7	7	22	7	7	7	7	7	7	7	52	20	None	None	7	7	14.2
Pb	15(a)	15	0.7	0.5	0.8	0.5	0.5	0.5	0.5	0.5	0.8	0.5	0.8	0.5	1.2	0.7	None	None	0.5	0.5	0.91
Sb	6	14	3	3	3	1	3	4	4	2	3	2	2	2	3	2	None	None	5	5	2.1
Se	50	50	0.5	0.4	0.6	0.4	0.4	0.4	0.6	0.4	1.2	0.4	0.4	0.4	0.4	0.4	None	None	0.4	0.4	0.82
Tl	2	1.7	**4**	**6**	**4**	**5**	**5**	**6**	**7**	**7**	**4**	**5**	**3**	1	1	1	A1-5,M (std)	A1-4,M (std)	1	1	1.14
V	--	--	10	11	3	3	3	3	3	3	5	6	3	3	4	3	None	None	3	3	5.2
Zn	5,000(s)	5,000	12	5	12	12	**30,890**	**13,280**	203	117	9	5	14	12	**22,720**	**14,100**	A2,6,C1 (std)	A2,6,C1 (std)	13	5	9.5
			n=6		n=8		n=8		n=8		n=7		n=1		n=1				n=0		
Chloride	250,000(s)	--	58,670	57,000	16,000	15,500	130,500	123,000	45,630	44,000	8,714	6,000	20,000	20,000	60,000	60,000	None	None	--	--	5000
Sulfate	250,000(s)	--	132,700	135,000	110,000	98,000	**504,500**	**282,000**	62,130	50,000	156,900	156,000	**278,000**	**278,000**	**1,730,000**	**1,730,000**	A2,5,6 (std)	A2,5,6 (std)	--	--	5000
Nitrate	10,000	--	5,503	5,335	502	585	53	38	31	25	1,039	1,100	50	50	80	80	None	None	--	--	50
COD	--	--	82,250	64,000	64,500	45,500	**193,900**	**175,000**	91,630	85,500	21,070	16,000	**534,000**	**534,000**	**431,000**	**431,000**	A2,5,6(bkd)	A2,5,6(bkd)	--	--	5000
SC	--	--	708	701	494	470	**1,979**	**1,650**	1,069	1,080	587	580	704	704	**2,880**	**2,880**	A2,A6(bkd)	A2,A6(bkd)	--	--	--

* MCL definitions: a = action level, not an MCL; s = secondary MCL (asthetics)
BDL values calculated as equal to one half the method detection limit (MDL)
Bolded values exceed established standards (significantly above background for constituents with no standard)

TABLE 5-2
OLD SILVER BOW LANDFILL GROUNDWATER DATA STATISTICAL SUMMARY
ORGANIC CONSTITUENTS (ug/L)
(updated 10/11/96)

	STANDARDS		MBMG-2		BSB-A1		BSB-A2		BSB-A3		BSB-A4		BSB-A5		BSB-A6		Mean Exceeds	Median Exceeds	BLANK		LAB
	MCL	HHS	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Std. or Bkd	Std. or Bkd.	Mean	Median	MDL
			n=6		n=8		n=8		n=8		n=7		n=4		n=4				n=8		
Acetone	--	--	10.1	1.65	10.9	1.65	1.65	1.65	26.1	1.65	1.89	1.65	2.46	1.65	1.65	1.65	None	None	8.63	1.65	3.3
Benzene	5	12	0.03	0.03	0.05	0.03	1.75	1.55	2.20	1.95	0.03	0.03	0.03	0.03	0.40	0.40	None	None	0.03	0.03	0.05
Carbon Disulfide	--	--	0.51	0.40	0.22	0.05	0.25	0.05	0.42	0.08	3.16	1.20	0.05	0.05	0.90	0.87	None	None	0.11	0.05	0.09
Chloroethane	--	--	0.05	0.05	0.05	0.05	0.05	0.05	**0.61**	**0.46**	0.05	0.05	0.05	0.05	0.05	0.05	A3 (bkd)	A3 (bkd)	0.05	0.05	0.1
Chloroform	--	57	0.83	0.82	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.05	None	None	0.05	0.05	0.09
Chloromethane	--	--	0.04	0.04	0.14	0.04	0.29	0.04	0.04	0.04	0.13	0.04	0.04	0.04	0.04	0.04	None	None	0.26	0.04	0.08
1,2-Dichlorobenzene-8260	600	600	0.09	0.09	0.09	0.09	0.38	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	None	None	0.09	0.09	0.17
1,4-Dichlorobenzene-8260	75	75	0.06	0.06	0.06	0.06	3.81	4.05	3.44	3.35	0.06	0.06	0.06	0.06	1.25	1.20	None	None	0.06	0.06	0.12
Dichlorodifluoromethane	--	6900	0.04	0.04	0.05	0.04	18.8	19.0	3.65	1.30	0.04	0.04	0.07	0.04	7.35	7.10	None	None	0.04	0.04	0.08
Dichlorofluoromethane	--	--	0.10	0.10	0.10	0.10	1.96	0.10	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.10	None	None	0.10	0.10	0.2
1,1-Dichloroethane	--	--	0.05	0.05	0.05	0.05	**12.1**	**12.5**	1.00	1.10	0.05	0.05	0.10	0.09	**5.20**	**5.60**	A2,A6 (bkd)	A2,A6 (bkd)	0.05	0.05	0.09
1,2-Dichloroethane	5	3.8	0.13	0.06	0.25	0.06	1.95	1.90	0.52	0.06	0.45	0.06	0.12	0.06	0.58	0.60	None	None	0.68	0.06	0.11
1,1-Dichloroethene	7	5.7	0.02	0.02	0.02	0.02	0.41	0.51	0.02	0.02	0.02	0.02	0.02	0.02	0.10	0.12	None	None	0.02	0.02	0.04
cis-1,2-Dichloroethene	70	70	0.05	0.05	0.20	0.05	**153**	**158**	41.0	37.0	0.06	0.05	1.26	1.40	59.0	57.5	A2 (std)	A2 (std)	0.05	0.05	0.09
trans-1,2-Dichloroethene	100	100	0.02	0.02	0.02	0.02	1.35	1.40	0.13	0.09	0.02	0.02	0.02	0.02	0.48	0.52	None	None	0.02	0.02	0.04
1,2-Dichloropropane	5	0.52	0.08	0.08	0.08	0.08	2.43	2.30	0.08	0.08	0.08	0.08	0.08	0.08	1.04	1.10	None	None	0.08	0.08	0.16
Ethylbenzene	700	700	0.04	0.04	0.04	0.04	0.11	0.04	1.90	1.65	0.04	0.04	0.04	0.04	0.04	0.04	None	None	0.04	0.04	0.08
Methyl Ethyl Ketone	--	--	2.48	2.48	2.48	2.48	2.55	2.48	11.0	2.48	2.48	2.48	2.48	2.48	2.48	2.48	None	None	2.48	2.48	4.95
Methyl Isobutyl Ketone	--	--	0.95	0.95	0.95	0.95	0.95	0.95	1.12	0.95	0.95	0.95	0.95	0.95	0.95	0.95	None	None	0.95	0.95	1.89
Methylene Chloride	5	47	0.03	0.03	0.03	0.03	1.30	1.50	0.03	0.03	0.03	0.03	0.03	0.03	0.25	0.23	None(blk)	None	**7.03**	0.03	0.06
Naphthalene	--	--	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	None	None	None	None	0.13	0.13	0.26
Tetrachloroethene	5	8	0.04	0.04	1.16	0.69	**6.09**	**6.50**	0.13	0.04	0.04	0.04	2.73	2.65	2.73	2.80	A2 (std)	A2 (std)	0.04	0.04	0.08
1,1,1-Trichloroethane	200	2000	0.02	0.02	0.02	0.02	1.11	0.02	0.48	0.02	0.02	0.02	0.02	0.02	0.02	0.02	None	None	0.02	0.02	0.03
Toluene	1000	1000	0.05	0.05	0.12	0.05	0.09	0.05	0.49	0.05	0.09	0.05	0.05	0.05	0.05	0.05	None	None	0.12	0.05	0.1
Trichloroethene	5	27	0.06	0.06	0.23	0.06	**13.1**	**14.0**	1.16	1.05	0.06	0.06	0.54	0.59	**5.93**	**6.10**	A2,A6 (std)	A2,A6 (std)	0.06	0.06	0.12
Trichlorofluoromethane	--	10000	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	None	None	0.06	0.07	0.14
Vinyl Chloride	2	20	0.15	0.15	0.15	0.15	**2.42**	**3.55**	0.62	0.42	0.15	0.15	0.15	0.15	0.89	0.91	A2 (std)	A2 (std)	0.14	0.15	0.3
m+p Xylenes	10000	10000	0.07	0.07	0.07	0.07	0.12	0.07	0.94	0.93	0.07	0.07	0.07	0.07	0.07	0.07	None	None	0.07	0.07	0.14
o-Xylene	10000	10000	0.04	0.04	0.04	0.04	0.09	0.04	0.14	0.14	0.04	0.04	0.04	0.04	0.04	0.04	None	None	0.03	0.04	0.07
			n=5		n=7		n=7		n=7		n=5		n=1		n=0				n=3		
1,2-Dichlorobenzene-8270	600	600	0.53	0.53	0.53	0.53	0.52	0.53	0.53	0.53	0.53	0.53	0.53	0.53	--	--	None	None	0.53	0.53	1.07
1,4-Dichlorobenzene-8270	75	75	0.64	0.64	0.64	0.64	2.37	2.30	1.94	2.20	0.64	0.64	0.64	0.64	--	--	None	None	0.64	0.64	1.27
Diethylphthalate	--	23000	0.37	0.37	0.37	0.37	8.46	3.80	2.08	2.10	0.37	0.37	0.37	0.37	--	--	None	None	0.37	0.37	0.73
Di-n-butylphthalate	--	2700	0.29	0.29	0.29	0.29	0.34	0.29	0.32	0.29	0.29	0.29	0.29	0.29	--	--	None	None	0.29	0.29	0.57
Di-n-octylphthalate	--	--	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	--	--	None	None	0.41	0.41	0.82
bis(2-ethylhexyl)phthalate	6	18	0.39	0.39	0.79	0.39	0.73	0.39	0.39	0.39	1.15	0.39	2.80	2.80	--	--	None	None	0.39	0.39	0.77
Acenaphthene	--	20	0.29	0.29	0.29	0.29	0.29	0.29	0.32	0.29	0.29	0.29	0.29	0.29	--	--	None	None	0.29	0.29	0.58
1-Methylnaphthalene	--	--	0.40	0.40	0.40	0.40	0.74	0.40	0.40	0.40	0.40	0.40	0.40	0.40	--	--	None	None	0.40	0.40	0.80
2-Methylphenol	--	--	0.37	0.37	0.37	0.37	0.37	0.37	9.17	0.37	0.37	0.37	0.37	0.37	--	--	None	None	0.37	0.37	0.73
4-Methylphenol/3-Methylphenol	--	--	0.30	0.30	0.30	0.30	0.67	0.30	0.41	0.30	0.30	0.30	0.30	0.30	--	--	None	None	0.30	0.30	0.60
Phenol	--	300	0.34	0.34	0.34	0.34	0.34	0.34	1.36	0.34	0.34	0.34	0.34	0.34	--	--	None	None	0.34	0.34	0.67
			n=2		n=4		n=4		n=4		n=2		n=1		n=0				n=1		
Picloram	500	500	0.153	0.153	0.002	0.002	0.122	0.002	0.022	0.002	0.002	0.002	0.091	0.091	--	--	None	None	0.002	0.002	0.003
2,4,5-T	50	--	0.002	0.002	0.002	0.002	0.167	0.002	0.039	0.002	0.002	0.002	0.002	0.002	--	--	None	None	0.002	0.002	0.003
2,4-D	70	70	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.110	0.110	--	--	None	None	0.011	0.011	0.023
4-Nitrophenol	--	--	0.153	0.153	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	--	--	None	None	0.005	0.005	0.009
Dacthal	--	--	0.0004	0.0004	0.0004	0.0004	0.0428	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	--	--	None	None	0.0004	0.0004	0.0009

BDL values calculated as equal to one-half the method detection limit (MDL)
Bolded values exceed established standards (significantly above background for constituents with no standard)

TABLE 5-3
SPLIT SAMPLE RESULTS - OLD BUTTE-SILVER BOW LANDFILL

SAMPLE NUMBER / WELL	BSB-GW-O1 MBMG-2		BSB-GW-O3 BSB-A4		BSB-GW-O5 BSB-A2	
ANALYTE	Current Laboratory	Check Laboratory	Current Laboratory	Check Laboratory	Current Laboratory	Check Laboratory
Antimony	0.009	<0.005	0.006	<0.005	<0.003	0.006
Cadmium	<0.0001	<0.0001	0.0001	<0.0001	0.0013	0.0011
Thallium	0.006	<0.002	0.005	<0.002	0.006	<0.002

All data in milligrams/liter.
Date Sampled: February 1, 1995

TABLE 5-4
OLD BUTTE-SILVER BOW COUNTY LANDFILL
BLANK SAMPLE COMPARISON

ANALYTE	FIELD BLANK (Filtered)	FIELD BLANK (Not Filtered)
Antimony	0.010	<0.003
Arsenic	<0.001	<0.001
Barium	<0.005	<0.005
Beryllium	0.0001	0.0001
Cadmium	<0.0001	<0.0001
Chromium	<0.009	<0.009
Cobalt	<0.010	<0.010
Copper	0.002	<0.001
Iron	<0.013	<0.013
Lead	<0.001	<0.001
Mercury	<0.0001	<0.0001
Nickel	<0.01	<0.01
Selenium	<0.001	<0.001
Silver	<0.0004	<0.0004
Thallium	<0.001	<0.001
Vanadium	<0.004	<0.004
Zinc	<0.01	<0.01

All data in milligrams/liter.
Date Sampled: March 1, 1995

TABLE 5-5
GEOPROBE INVESTIGATION GROUNDWATER DATA

ANALYTE (units):	LABORATORY ANALYSIS			FIELD GC ANALYSIS		
	BSB-SGO1	BSB-SG11	BSB-SG12	BSB-SGO1	BSB-SG11	BSB-SG12
DISSOLVED METALS (mg/L)						
Antimony	0.004	-	0.004	-	-	-
Arsenic	0.081	-	<0.001	-	-	-
Barium	0.100	-	0.069	-	-	-
Beryllium	<0.0001	-	0.0001	-	-	-
Cadmium	<0.0001	-	<0.0001	-	-	-
Chromium	<0.008	-	<0.008	-	-	-
Copper	0.003	-	0.009	-	-	-
Iron	7.00	-	0.507	-	-	-
Lead	<0.001	-	<0.001	-	-	-
Mercury	<0.0001	-	0.0001	-	-	-
Nickel	<0.01	-	0.02	-	-	-
Selenium	<0.001	-	<0.001	-	-	-
Silver	<0.004	-	<0.004	-	-	-
Thallium	<0.001	-	<0.001	-	-	-
Vanadium	<0.004	-	<0.004	-	-	-
Zinc	0.118	-	0.029	-	-	-
VOCs (ug/L)						
Acetone	<50	76 B	-	-	-	-
Benzene	<1.0 (0.38J)	<1.0 (0.68J)	-	-	-	-
Carbon Disulfide	8.7	3.1	-	-	-	-
Chloroethane	<1.0	<1.0	-	-	-	-
Chloroform	<1.0	<1.0	-	-	-	-
1,2-Dichlorobenzene	<1.0	<1.0	-	-	-	-
1,4-Dichlorobenzene	<1.0	<1.0	-	-	-	-
Dichlorodifluoromethane	<1.0	<1.0	-	-	-	-
1,1-Dichloroethane	<1.0	<1.0	-	<0.5	4.6	0.6
1,2-Dichloroethane	<1.0 (0.31J)	<1.0 (0.30J)	-	-	-	-
1,1-Dichloroethene	<1.0	<1.0	-	-	-	-
cis-1,2-Dichloroethene	2.4	<1.0	-	1.7	5.9	<0.5J
trans-1,2-Dichloroethene	<1.0	<1.0	-	-	-	-
1,2-Dichloropropane	<1.0	<1.0	-	-	-	-
Ethyl Benzene	<1.0 (0.52J)	<1.0 (0.24J)	-	-	-	-
Methyl Ethyl Keytone	<20	32	-	-	-	-
Methylene Chloride	<1.0	<1.0	-	-	-	-
Naphthalene	1.8	2.0	-	-	-	-
Tetrachloroethene	<1.0	<1.0	-	<0.5	<0.5J	<0.5
Toluene	2.1	1.4	-	-	-	-
Trichloroethene	1.1	<1.0	-	<0.5J	1.0	<0.5J
Trichlorofluoromethane	<1.0	<1.0	-	-	-	-
Vinyl Chloride	<1.0	<1.0	-	-	-	-
m+p Xylenes	2.6	<1.0 (0.79J)	-	-	-	-
o-Xylene	1.7	<1.0 (0.39J)	-	-	-	-

- = Not analyzed.
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank.

TABLE 5-6: DOWNGRADIENT WELL SAMPLING RESULTS

SAMPLE NUMBER WELL	RE-3 K. REAP	BL-4 BLANKENSHIP	CR-1 CREMATORIUM	CE-2 CEMETERY MIDDLE	DRINKING WATER MCL
DISSOLVED METALS (mg/L)					
Antimony	0.009			NR	0.006
Arsenic	0.002	0.002	NR	NR	0.05
Barium	0.017	<0.002	NR	NR	2
Beryllium	0.0003	<0.0001	NR	NR	0.004
Cadmium	0.0002	<0.0001	NR	NR	0.005
Chromium	<0.009	<0.009	NR	NR	0.1
Cobalt	<0.010	<0.010	NR	NR	
Copper	<0.002	0.016	NR	NR	
Iron	10.7	0.088	NR	NR	
Lead	0.003	<0.001	NR	NR	(0.015)*
Mercury	<0.0001	<0.0001	NR	NR	0.002
Nickel	<0.01	<0.01	NR	NR	
Selenium	<0.001	<0.001	NR	NR	0.05
Silver	<0.001	<0.001	NR	NR	
Thallium	0.003	<0.001	NR	NR	0.002
Vanadium	0.006	0.006	NR	NR	
Zinc	0.073	0.539	NR	NR	
EPA METHOD 8260 (ug/L)					
Chlormethane	NR	3.0	1.6	2.6	
Chloroform	NR	<1.0	<1.0	<1.0 (0.33J)	
1,2-Dichloroethane	NR	1.2	<1.0 (0.65J)	<1.0(0.74J)	5
Tetrachloroethene	NR	<1.0	<1.0	<1.0 (0.35J)	5

* Value is an action level, not a MCL.
NR = Not Requested
J= Estimated Quanitity. Analyle present, but less than the quantitation limit (PQL).
Only those constituents detected via EPA method 8260 are reported.

TABLE 5-7: SELECTED DATA FROM MBMG GROVE GULCH SAMPLING EVENTS

SAMPLE LOCATION	DATE	FIELD PARAMETERS					Hardness	Alkalinity	CATIONS/ANIONS (mg/L)										DISSOLVED METALS (ug/L)					
		Q (gpm)	pH	Eh (mv)	Specific Cond. (umhos/cm)	Temp. (C)	(mg/L)	(mg/L)	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO3-N	F	As	Cu	Li	Pb	Sr	Zn
UPGRADIENT	05/15/91	315	8.1	97	395	9.5	130.1	78.2	37.9	8.6	15.3	4.7	0.15	0.06	7.3	62.1	0.15	0.54	5.3	21	12	<40	228	176
UPGRADIENT	03/06/92	180	8.2	27	276	3.3	106.5	73.6	30.6	7.3	11.8	6.8	0.25	0.17	6.7	59.2	0.23	0.5	8	11	<6	1	191	20
UPGRADIENT	06/19/92	68	7.6	249	360	17	181.1	132.1	53.4	11.6	16.2	4.3	0.07	0.09	7.8	67.9	0.07	1.22	6.9	12	20	<100	311	<10
UPGRADIENT	08/20/92	2	7.7	-67	372	19	167.9	150.9	49.1	11	16.5	6.4	0.1	0.04	5.7	51.6	0.1	0.54	6.4	18	<6	<3	272	20
UPGRAD, ARITHMATIC MEAN		141			351	12.2	146.4	108.7	42.8	9.6	15	5.6	0.14	0.09	6.9	60.2	0.14	0.7	6.7	16	11	36	251	57
UPGRAD, GEOMETRIC MEAN		53			348	10	143.3	103.5	41.8	9.5	14.8	5.4	0.13	0.08	6.8	59.9	0.12	0.65	6.6	15	10	10	246	29
DOWNGRADIENT	05/15/91	495	7.6	139	440	11.7	167.4	115.2	48.9	11	18.6	5.6	0.6	0.83	15.4	72.3	0.1	0.78	7.2	19	9	<40	280	53
DOWNGRADIENT	03/06/92	180	8.1	N/A	385	6.5	152.9	107.3	44.4	10.2	15.6	7.5	0.53	0.76	13.8	72.6	0.36	0.67	7	5	6	<1	249	30
DOWNGRADIENT	06/19/92	135	7.3	229	469	16.9	213.3	162.3	61.2	14.7	20.7	6.6	0.18	1.54	20.7	70.9	0.05	1	10	<10	7	<100	350	20
DOWNGRADIENT	08/20/92	22	7.2	-27	540	12.1	232	192.7	67.2	15.6	22.1	6.6	2.55	3.93	26	67	1.28	0.69	14.7	2	<6	<1	376	36
DOWNGRAD, ARITHMATIC MEAN		208			459	11.8	191.4	144.4	55.4	12.9	19.3	6.6	0.97	1.77	19	70.7	0.45	0.79	9.7	9	7	36	314	35
DOWNGRAD, GEOMETRIC MEAN		128			455	11.2	188.7	140.2	54.7	12.7	19.1	6.5	0.62	1.4	18.4	70.7	0.22	0.77	9.3	7	7	8	309	33

SOURCE: Montana Bureau of Mines and Geology unpublished data (MBMG, 1995).

NOTES:
1. Upgradient = Grove Gulch above landfill.
2. Downgradient = Grove Gulch below landfill, near Montana St.
3. < = not detected at the reported detection limit.
4. Undetected parameters were considered present at their detection limit when calculating means.

TABLE 5-8

SOIL GAS SAMPLE RESULTS FROM THE OLD SILVER BOW LANDFILL

Location	Date	Depth (ft bgs)	VOC Concentration (μg/L)				
			1,1-Dichloroethane	Cis-1,2-dichloroethene	1,1,1-Trichlorethane	Trichloroethene	Tetrachloroethene
BSB-SG1	2/7/96	20.0	<2.5	<2.5	<2.5	<2.5	<2.5
BSB-SG1	2/7/96	38.0	<2.5J	<2.5	<2.5	<2.5	<2.5
BSB-SG4	2/7/96	3.5	<2.5J	<2.5	<2.5	<2.5	<2.5
BSB-SG4	2/7/96	10.0	<2.5J	<2.5	<2.5	<2.5	<2.5
BSB-SG5	2/7/96	3.0	<2.5J	<2.5	<2.5	<2.5	<2.5
BSB-SG6	2/7/96	8.5	24.1	4.1	55.6	<2.5J	<2.5
BSB-SG7	2/7/96	5.0	11.7	2.9	21.4	<2.5J	<2.5
BSB-SG8	2/7/96	5.0	9.2	<2.5J	7.3	<2.5J	<2.5J
BSB-SG9	2/8/96	4.0	12.7	<2.5J	<2.5	<2.5	<2.5
BSB-SG10	2/8/96	4.5	<2.5J	<2.5	<2.5	<2.5	<2.5J
BSB-SG10	2/8/96	12.0	3.5	<2.5	<2.5	<2.5J	5.6
BSB-SG14	2/8/96	4.5	<2.5J	<2.5	<2.5	<2.5	<2.5

J - Constituent detected but is less than the reported quantitation limit.

TABLE 6-1

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
No Action	Not Applicable	Not Applicable
Institutional Controls	Access Restrictions	Fencing Land Use Control Groundwater Use Restrictions
Containment	Capping	Native Soil Cover Low Permeabilty Soil Cover Geosynthetic Cover Multimedia Cover Asphalt/Concrete Cover Wet Closure
	Surface Controls	Consolidation Grading Revegetation Erosion Protection Run-on/Run-off Control
	Vertical Barriers	Slurry Wall Vibrating Beam Grout Curtains Sheet Piling Permeability Reduction Agents Ground Freezing
	Horizontal Barriers	Block Displacement Grout Injection Ground Freezing Liners
	Sediment Control	Curtain Barriers Cofferdams Capping Barriers Sandbags Settling Basins
	Dust Suppression	Watering Polymers and Foams Membranes Hygroscopic Agents
Removal	Solids Removal	Excavation Partial Excavation

TABLE 6-1 (Cont'd)

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
	Liquids Removal	Pumping Bailing Gravity/Siphon Dredging
	Groundwater Collection	Wells Trench Drains
	Soil Vapor Extraction	Passive Extraction Active Extraction
	Landfill Gas Extraction	Passive Extraction Active Extraction
Solids Treatment	Physical/Chemical Treatment	Chemical Fixation Neutralization Oxidation Chemical Reduction Water Leaching Solvent Leaching Land Farming Soil Washing Acid Extraction Alkaline Leaching
	Thermal Treatment	Incineration Vitrification
	In Situ Treatment	Stabilization/Solidification Soil Flushing Vitrification Neutralization Oxidation Precipitation Bioremediation Thermal Evaporation Steam Stripping Soil Vapor Extraction

TABLE 6-1 (Cont'd)

GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS AT THE OLD BUTTE LANDFILL/CLARK TAILINGS SITE

GENERAL RESPONSE ACTION	TECHNOLOGY TYPE	PROCESS OPTIONS
Non-Solids Treatment	Physical Treatment	Coagulation/Flocculation Non-Aqueous Phase Liquids Separation Flotation Filtration Adsorption Membrane Processes Freeze Crystallization Air Stripping Steam Stripping Evaporation Distillation Liquid-Liquid Extraction Critical Fluid Extraction
	Chemical Treatment	Neutralization Precipitation Ion Exchange Oxidation Reduction Organic Chemical Dechlorination Irradiation
	Biological Treatment	Aerobic Processes Anaerobic Processes Facultative Processes Land Treatment Wetland Treatment Publicly-Owned Treatment Works
	Thermal Treatment	Incineration Co-Disposal Processes Pyrolosis Wet Air Oxidation
	In Situ Treatment	Air Sparging Soil Vapor Extraction Bioremediation Landfill Gas Extraction
Monitoring	Monitoring	Monitoring

TABLE 6-2

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
NO ACTION	None	Not Applicable	No Action	Alternative is retained as a basis for comparison.
INSTITUTIONAL CONTROLS	Access Restrictions	Fencing	Security fences installed around contaminated areas to limit access.	Potentially effective in conjunction with other technologies readily implementable.
		Land Use Control	Restrictions to control current and future land use.	Potentially effective in conjunction with other process options. Readily implementable.
		Groundwater Use Controls	Restrictions on the development and use of the aquifer in the vicinity of the site.	Potentially applicable at the site to prevent development and use of contaminated groundwater.
CONTAINMENT	Capping	Native Soil Cover	Application of soil and establishment of vegetative cover to stabilize surface of contamination source.	Surface infiltration and runoff potential would be reduced, but not prevented. Readily implementable. Required, at a minimum, on portions of landfill which received waste prior to October 9, 1991.
		Low Permeability Soil Cover	Application of compacted low permeability soil (clay) to provide a barrier to prevent infiltration of water.	Surface infiltration reduced. Readily implementable, usually in conjunction with a vegetated native soil cover to prevent erosion and freezing. Required on portions of landfill which received waste after October 9, 1991.
		Geosynthetic Cover	Application of a geosynthetic membrane (such as HDPE or PVC) over areas of contamination.	Surface infiltration reduced. Potentially effective at source control and readily implementable.
		Multimedia Cap	Compacted clay and geosynthetic membrane materials covered with soil/vegetation over areas of surface contamination.	Surface infiltration minimized. Potentially effective for source control and readily implementable.
		Asphalt/Concrete Cover	Application of layer asphalt or concrete over areas of surface contamination.	Limited feasibility due to remoteness of area and steep slopes. Would require extensive grading and compaction.
		Wet Closure	Construct dam to flood tailings with water and provide anaerobic environment to limit oxidation/migration of contaminants.	Not effective for landfill source control. Not applicable to tailings due to local topography.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
	Surface Controls	Consolidation	Combining similar waste types in a common area.	Potentially applicable and effective in conjunction with other process options. Readily implementable.
		Grading	Redefine topography to reduce severe slopes and increase shallow slopes for managing surface water infiltration, run-on, runoff, and erosion.	Potentially effective in conjunction with other process options. Readily implementable.
		Revegetation	Adding amendments to waste or waste cover and seeding with appropriate vegetative species to establish an erosion resistant ground surface and an evapotranspirative layer to prevent infiltration.	Potentially effective. Readily implementable.
		Erosion Protection/Run-on, Runoff Control	Erosion resistant materials/fabrics placed directly on waste sources or covers to reduce surface erosion. Surface water diversion structures constructed to direct runoff away from waste source(s).	Potentially effective at reducing contaminant mobility. Readily implementable.
	Vertical Barriers	Slurry Wall	Trench around contaminated area is excavated and backfilled with a low permeability slurry.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. Difficult to implement because of uncertainties about depth of fill and depth to groundwater.
		Vibrating Beam	Steel beam barrier is driven into ground and then withdrawn as a low permeability material (i.e. bentonite) is injected.	"
		Grout Curtains	Grout is injected around contaminated area to form low permeability subsurface barrier.	"
		Sheet Piling	Steel sheet piling is driven around contaminated areas to an impermeable subsurface barrier.	"
		Permeability Reduction Agents	Grout or polymer is injected into the soil matrix to reduce permeability.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. However, process is experimental and not proven to be effective.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Ground Freezing	Coolant is circulated through refrigeration pipes to freeze the ground, creating an impermeable subsurface barrier.	Potentially effective at preventing subsurface infiltration of upgradient groundwater. Difficult to implement because of uncertainties about depth of fill and depth to groundwater. Known to be not cost-effective.
	Horizontal Barriers	Block Displacement	Injection of slurry creates a horizontal barrier (liner) below the contamination source.	Experimental process is not proven to be effective.
		Grout Injection	Grout injected through borings to create a horizontal barrier below waste.	"
		Ground Freezing	Ground below contamination source is frozen by circulating coolant.	"
		Liners	Liners placed to minimize transfer of leachate from contamination source into underlying soils and/or aquifers.	Proven effective. However, not implementable at this site due to volume and depth of waste in place.
	Sediment Control	Curtain Barriers	Curtains placed in water bodies to prevent migration of sediments.	Not applicable to waste forms at site.
		Cofferdams	Cofferdams installed to isolate areas of contaminated sediments.	"
		Capping Barriers	Contaminated sediments are capped to prevent migration.	"
		Settling Basins	Basins are constructed to detain or retain flow to allow entrained solids from migrating from site.	Potentially applicable to prevent migration of contaminated materials eroded by run-off. Process is currently being applied at the site.
	Dust Suppression	Watering	Water sprayed over area to prevent dust generation.	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Polymers and Foams	Organic agents, polymers, and/or foams sprayed over area to prevent dust generation	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities. Less cost-effective than watering.
		Membranes	Membranes or tarps are spread over area to prevent dust generation.	Potentially effective, but not implementable at this site.
		Hygroscopic Agents	Hygroscopic salts are added to soils to attract water to the soils, preventing dust generation.	Potentially effective to prevent airborne migration of contaminants, particularly during construction activities. Less cost-effective than watering.
REMOVAL	Solids Removal	Excavation	Removal of solid contamination source with conventional excavating equipment.	Potentially effective, but not implementable at this site due to volume of waste present.
		Partial Excavation	Excavation of solids from sensitive areas with conventional excavating equipment.	Potentially effective and implementable.
	Non-Aqueous Phase Liquids Removal	Pumping	Large quantities of free liquids are removed with pumps.	Not applicable to the waste forms at this site.
		Bailing	Small amounts of free liquids or sludges are removed with bailers.	"
		Gravity/Siphon	Liquids are removed from tanks or ponds by draining or siphoning.	"
		Dredging	Sludges and associated liquids are dredged from water bodies.	"
	Groundwater Collection	Wells	Wells are installed in the aquifer to collect and remove (via pumping or bailing) contaminated groundwater.	Readily implementable. However, technology has had marginal effectiveness at achieving groundwater protection standards.
		Trench Drains	Gravel-filled trenches collect contaminated groundwater.	Readily implementable. However, technology has had marginal effectiveness at achieving groundwater protection standards.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
	Soil Vapor Extraction	Passive Extraction	Passive soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Potentially applicable for gaseous-phase contaminants. Readily implementable.
		Active Extraction	Wells and/or trenches are installed and placed under vacuum to soil vapors.	Potentially applicable for gaseous-phase contaminants. More difficult to implement than passive extraction.
	Landfill Gas Extraction	Passive Extraction	Passive soil vents are installed in and around a landfill to intercept landfill gas and vent it to the atmosphere.	Applicable to landfill portion of the site. Potentially effective at mitigating organic contamination caused by landfill gas. Readily implementable.
		Active Extraction	Wells and/or trenches are installed in and around a landfill and placed under vacuum to collect landfill gas.	Applicable to landfill portion of the site. Potentially effective at mitigating organic contamination caused by landfill gas. More difficult to implement than passive extraction due to permitting requirements.
SOLIDS TREATMENT	Physical/Chemical Treatment	Chemical Fixation	Hazardous solids are mixed with reagents (often portland cement and pozzolonic materials) to produce a non-leachable product.	Potentially effective on inorganic solids (Clark Tailings). However, would require extensive testing and appropriate final disposal. Not readily implementable or cost-effective due to volume of waste requiring removal and treatment.
		Neutralization	Acid added to alkaline wastes or base added to acidic wastes to adjust the pH to near neutral.	Potentially effective on acidic tailings. Readily implementable.
		Oxidation	Oxidizing agents added to waste to oxidize organic contaminants.	Potentially effective on organic wastes. Not implementable due to volume of solid waste present and heterogenous nature of solid waste.
		Chemical Reduction	Reducing agents added to waste to stabilize metals by reducing them to less mobile oxidation states.	Potentially effective on oxidized inorganic solids. Not implementable due to volume of the tailings media present at the site.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Land Farming	Solid media contaminated with organic wastes are mixed with soil by tilling and the wastes are degraded by volatilization, photolysis, and biological processes.	Not applicable to the waste forms present at the site.
		Soil Washing	Hazardous constituents are separated from solid media via dissolution (in water or solvents) and subsequent precipitation.	Effectiveness is questionable. Potential exists to increase mobility by providing partial dissolution of contaminants. More difficulty encountered by wider range of CoCs.
		Acid Extraction	Hazardous constituents are leached from solid media with acid and recovered via subsequent precipitation.	Effectiveness is questionable. Sulfides present in tailings would be acid soluble under extreme conditions of temperature and pressure. Not readily implementable due to volume of the tailings media present at the site.
		Alkaline Leaching	An alkaline solution is used to leach contaminants from solid media.	Effectiveness is not well-documented. Not readily implementable due to volume of the tailings media present at the site.
	Thermal Treatment	Incineration	Solid media are incinerated in a fluidized bed kiln, rotary kiln, or multi-hearth kiln. Organic hazardous constituents are destroyed. Inorganic constituents are volatilized or retained in the solids (ash) fraction.	Potentially effective. However, waste streams would require further treatment. Not readily implementable due to the volume of waste present at the site and high cost.
		Vitrification	Extremely high temperatures used to melt and/or volatilize all components of the solid media. The molten material containing contaminants is cooled and vitrified into a stable, unleachable form.	Further treatment is required to treat process byproducts (off-gases). Not readily implementable due to the volume of waste present at the site and high cost.
	In Situ Treatment	Stabilization/ Solidification	Solid media waste constituents are solidified and/or stabilized in place by mixing with stabilizing agents. Can be accomplished in situ with deep soil mixing techniques.	Potentially effective on tailings. However, extensive treatability testing is required. Not implementable due to volume of tailings.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Soil Flushing	Acid/base reagents or chelating agents injected into solid media to solubilize metals. The solution is then extracted using dewatering techniques.	Effectiveness not certain. Innovative process currently at pilot stage. Potential exists that metals will be solubilized and not collected, thus leaching to the aquifer and exacerbating the groundwater contamination problem.
		Vitrification	Solid media are subjected to extremely high temperatures in place. During cooling, material is vitrified into a stable, unleachable form.	New technology at pilot-scale. Difficulties may be encountered in establishing proper process control. Potentially implementable, but cost-prohibitive.
		Neutralization	Substances applied or injected into a contaminated site to adjust the pH of the waste.	Potentially effective on tailings. Readily implementable.
		Oxidation	Oxidizing agents added to waste to oxidize organic contaminants.	Potentially effective to organic wastes. Not implementable due to volume of solid waste present and heterogenous nature of solid waste.
		Precipitation	Substances applied to soils to promote precipitation of metals.	Experimental process has not been proven effective.
		Bioremediation	Microbiological degradation of hazardous substances. Conditions are controlled through amendments to enhance biological activity, thus increasing the rate of degradation.	Not effective on the solid waste media present at the site, considering the heterogenous nature of the waste.
		Thermal Evaporation	Solid waste media are heated electronically, volatilizing organic hazardous substances.	Not effective on the solid waste media present at the site, considering the heterogenous nature of the waste. Cost-prohibitive.
		Steam Stripping	VOCs are removed from solid media (soils) by steam. Steam is injected through wells, routed through the contaminated media, and extracted through different wells.	Not applicable to the solid waste media present at the site.
		Soil Vapor Extraction	Passive and/or active soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Potentially applicable to gaseous-phase contaminants. Readily implementable.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
NON-SOLIDS TREATMENT	Physical Treatment	Coagulation/ Flocculation	Suspended solids are removed by addition of flocculents to waste stream. Small particles are collected on the flocculent and then removed by gravity.	Not applicable to the known groundwater contaminants at the site (dissolved metals and VOCs).
		Non-Aqueous Phase Liquids Separation	Non-aqueous phase liquids are separated from water by gravity (i.e. oil-water separation).	Not applicable to known waste forms at the site.
		Flotation	Suspended solids and non-aqueous phase liquids are attached to gas bubbles are floated to the surface of an aqueous solution, where they are skimmed.	Not applicable to the groundwater contaminants at the site.
		Filtration	Solids are removed from by running the aqueous solution through a filter medium (membrane or aggregate).	Not directly applicable to the groundwater contaminants at the site. Potentially applicable and implementable as a polishing process after other treatment technologies such as precipitation.
		Adsorption	Liquid or gas is passed over adsorption media (i.e. activated carbon), to which contaminants are attached.	Proven effective for VOC removal from groundwater. Readily implementable.
		Membrane Processes	A waste stream is forced through a membrane which selectively allows some components to pass while retaining others (reverse osmosis).	Potentially effective at removing groundwater contaminants after groundwater removal. Implementable.
		Freeze Crystallization	Dissolved solids are removed from solution by freezing.	Potentially effective at removing dissolved solids from groundwater. However, process is seldom used at full scale due to high cost.
		Air Stripping	Air is forced through liquid, or liquids are cascaded through a tower with air flowing in the opposite direction, to transfer volatile components from the liquid to air.	Proven effective for VOC removal. Readily implementable.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Steam Stripping	The same as air stripping, except that the media are heated to enhance the transfer from of volatile from solution to the gaseous phase.	Costs are much higher than for air stripping, which provides similar effectiveness for the VOC contaminants in the groundwater.
		Evaporation	Water is evaporated, leaving non-volatile contaminants in a concentrated solution. Evaporated water can be collected and condensed.	Potentially effective for the contaminants present. Not considered implementable because of high energy requirements and cost.
		Distillation	Contaminated solution is heated to volatilize specific organic contaminants. Vapor-phase is collected and condensed for the recovery or further treatment of the organics.	Not cost-effective for low concentrations of contaminants at the site.
		Liquid-Liquid Extraction	Contaminants are transferred from one liquid to a second, immiscible liquid by mixing or countercurrent flow. Similar to air stripping.	Potentially effective for VOCs but requires further treatment of solvent. High cost.
		Critical Fluid Extraction	Contaminants from a waste stream are transferred to a gas at critical conditions; when the gas returns to atmospheric conditions, the contaminants are separated from it.	Not effective for low VOC concentrations in groundwater at the site. High cost.
	Chemical Treatment	Neutralization	Reagents added to waste stream to adjust pH to neutrality.	Not effective on groundwater the site, which is at a pH near neutral.
		Precipitation	Reagents that effect thermodynamic equilibria of contaminants are added to a solution, resulting in the precipitation of dissolved contaminants.	Potentially effective for removal of inorganics. Readily implementable.
		Ion Exchange	Contaminant ions are exchanged with those of an ion exchange resin, replacing them in solution with non-hazardous constituents.	Potentially effective for removal of inorganics. Readily implementable.
		Oxidation	Oxidizing agents added to solution to oxidize inorganics and some organics to less toxic oxidation state or destroy some organics.	Potentially effective for some contaminants, but not all.
		Reduction	Reducing agents added to solution to reduce some inorganics to less toxic or soluble oxidation states.	Potentially effective for some contaminants, but not all.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
		Organic Chemical Dechlorination	Reagents added to solution to remove chlorine ions from chlorinated hydrocarbons.	Experimental process option, not proven effective.
		Irradiation	Waste stream is subjected to radiation to promote chemical, physical, and/or biological changes, resulting in the reduction in toxicity or destruction of hazardous constituents.	Potentially effective on gaseous-phase wastes.
	Biological Treatment	Aerobic Processes	Organic wastes degraded and/or mineralized by a mixed culture of microorganisms in aerobic conditions. Inorganics oxidized and sequestered to waste fraction (sludge).	Effective for removal of VOCs; potentially effective for concentration of inorganics in waste fraction (sludge). Implementable. Process is in use at the publicly-owned treatment works.
		Anaerobic Processes	Organic wastes degraded and/or mineralized by a mixed culture of microorganisms in anaerobic conditions.	Potentially effective for VOCs and inorganic treatment. Implementable.
		Facultative Processes	Organics and inorganics removed from waste stream through use of a mixed culture of facultative microorganisms in aerobic and anaerobic conditions.	Effectiveness not proven for VOC removal.
		Land Treatment	Waste water and/or sludges are applied to open land. Organics are biodegraded; nutrients and metals are consumed by vegetation or are adsorbed to soils.	Effectiveness for certain constituents is uncertain. Winter-time effectiveness is questionable.
		Wetlands Treatment	Metals are removed by biological and chemical/physical processes in the facultative conditions of a wetland.	Potentially effective if adequate space is available. Not proven at full-scale in similar climates.
		Publicly-Owned Treatment Works	Contaminated water is combined with municipal sewage and treated at the POTW. In this case, POTW employs aerobic activated sludge followed by anaerobic digestion of sludge. VOCs removed during aerobic process; metals sequestered to sludge fraction.	Processes at POTW are proven effective for wastes present at the site. Would require permitting by the POTW and possible pretreatment to remove specific constituents.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
	Thermal Treatment	Incineration	Hazardous materials thermally destroyed by incineration at high temperatures.	Effective and potentially implementable for gaseous-phase wastes. Facilities not readily available to accommodate volume of liquid- or solid-phase wastes at the site.
		Co-Disposal Processes	Waste materials mixed with other materials and used as a supplemental fuel source.	Not applicable to liquid or gaseous-phase wastes.
		Pyrolysis	Hazardous materials destroyed in an oxygen deficient atmosphere.	Not applicable to liquid or gaseous-phase wastes.
		Wet Air Oxidation	Waste is mixed with air and hazardous constituents are destroyed at high temperatures and pressures.	Potentially effective, but costly. Other process options equally effective but less costly.
	In Situ Treatment	Air Sparging	Air is injected into groundwater to promote in situ volatilization of organic contaminants.	Potentially effective for VOC contaminants. Readily implementable. Concern over potential to cause migration of hazardous constituents.
		Soil Vapor Extraction	Passive and/or active soil vents are installed to intercept soil vapors and vent them to the atmosphere.	Potentially effective for removal of VOC contaminants. Readily implementable.
		Bioremediation	Microbiological degradation of hazardous substances in groundwater. Conditions are enhanced by adding amendments to groundwater to promote biological activity, thus increasing the rate of degradation.	Potentially effective for treatment of organic contaminants. Readily implementable.
		Landfill Gas Extraction	Passive and/or active soil vents are installed in and around a landfill to intercept landfill gas and vent it to the atmosphere, preventing groundwater contamination.	Potentially effective for VOC contaminants in groundwater that are transferred to groundwater from landfill gas.

TABLE 6-2 (Cont'd)

OLD BUTTE LANDFILL/CLARK TAILINGS
CORRECTIVE MEASURES TECHNOLOGY SCREENING SUMMARY

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTIONS	DESCRIPTION	SCREENING COMMENT
MONITORING	Monitoring	Monitoring	Monitoring of site conditions implemented to record and track site conditions and contamination levels.	Potentially effective if there is currently no risk to human health and the environment but there is potential for future risk if contaminants migrate. Also potentially effective in conjunction with other corrective measures. Readily implementable.

Legend

- Technologies/Process options that are screened out.

TABLE 6-3
CORRECTIVE MEASURES ALTERNATIVES FOR THE OLD LANDFILL/CLARK TAILINGS SITE

ALTERNATIVE 1:	NO ACTION
ALTERNATIVE 2:	INSTITUTIONAL CONTROLS
ALTERNATIVE 3:	NATIVE MATERIALS CAPPING
ALTERNATIVE 4:	NATIVE MATERIALS CAPPING WITH INSTITUTIONAL CONTROLS
ALTERNATIVE 5:	LOW PERMEABILITY CAPPING WITH INSTITUTIONAL CONTROLS
ALTERNATIVE 6:	MULTIMEDIA CAPPING WITH INSTITUTIONAL CONTROLS
ALTERNATIVE 7:	VERTICAL GROUNDWATER BARRIERS WITH CAPPING AND INSTITUTIONAL CONTROLS
ALTERNATIVE 8:	LANDFILL GAS REMOVAL WITH CAPPING AND INSTITUTIONAL CONTROLS
ALTERNATIVE 9:	GROUNDWATER REMOVAL AND TREATMENT WITH CAPPING AND INSTITUTIONAL CONTROLS
ALTERNATIVE 10:	IN SITU GROUNDWATER TREATMENT WITH CAPPING AND INSTITUTIONAL CONTROLS

TABLE 6-4

PRELIMINARY COST ESTIMATE - ALTERNATIVE 2
INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization	1	L.S.	1000	1000	Estimate
Construct Chain Link Fence	10000	L.F.	7.5	75000	ARCO Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				131000	
Engineering / Oversight (10%)				13100	
Subtotal Capital Costs				144100	
Contingency (10%)				14410	
TOTAL CAPITAL COSTS				$158,510	
POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	/Year	1500	18000	Experience
Maintenance	1	L.S.	2000	2000	Estimate
Subtotal				21000	
Contingency (10%)				2100	
ANNUAL 30 YEAR O&M COST				$23,100	

TABLE 6-4 Continued

TOTAL CAPITAL COSTS	158510
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	355104
TOTAL PRESENT WORTH COST	**$513,614**

TABLE 6-5

PRELIMINARY COST ESTIMATE - ALTERNATIVE 3
NATIVE MATERIALS CAPPING

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Construct Clark Tailings Cap	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Subtotal				842300	
Engineering / Construction Oversight (15%)				126345	
Subtotal Capital Costs				968645	
Contingency (10%)				96865	
TOTAL CAPITAL COSTS				$1,065,510	

TABLE 6-5 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Maintenance	1	L.S.	3000	3000	Estimate
Subtotal				22000	
Contingency (10%)				2200	
ANNUAL 30 YEAR O&M COST				$24,200	

TOTAL CAPITAL COSTS	1065510
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	372013
TOTAL PRESENT WORTH COST	**$1,437,523**

TABLE 6-6

PRELIMINARY COST ESTIMATE - ALTERNATIVE 4
NATIVE MATERIALS CAPPING WITH INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Construct Clark Tailings Cap	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				897300	
Engineering / Construction Oversight (15%)				134595	
Subtotal Capital Costs				1031895	
Contingency (10%)				103190	
TOTAL CAPITAL COSTS				$1,135,085	

TABLE 6-6 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Maintenance	1	L.S.	7000	7000	Estimate
Subtotal				26000	
Contingency (10%)				2600	
ANNUAL 30 YEAR O&M COST				$28,600	

TOTAL CAPITAL COSTS	1135085
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	439652
TOTAL PRESENT WORTH COST	**$1,574,737**

TABLE 6-7

PRELIMINARY COST ESTIMATE - ALTERNATIVE 5
LOW PERMEABILITY CAPPING WITH INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Clark Tailings Infil. Barrier Layer	52	Acres	9000	468000	Bid Tabulations
Clark Tailings Capillary Break Layer	52	Acres	10000	520000	Bid Tabulations
Clark Tailings Cover Soil	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate

Needs 20 Yr O&M.
52 @ 4000

TABLE 6-7 Continued

Subtotal	1975300
Engineering / Construction Oversight (15%)	296295
Subtotal Capital Costs	2271595
Contingency (10%)	227160
TOTAL CAPITAL COSTS	**$2,498,755**

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				29000	
Contingency (10%)				2900	
ANNUAL 30 YEAR O&M COST				$31,900	

TOTAL CAPITAL COSTS	2498755
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	490381
TOTAL PRESENT WORTH COST	**$2,989,136**

TABLE 6-8

PRELIMINARY COST ESTIMATE - ALTERNATIVE 6
MULTIMEDIA CAPPING WITH INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Install Geosynthetic Cap Liner	114	Acres	24000	2736000	MDEQ Bid Tabulations
Install 20-mil Flexible Membrane Liner	114	Acres	9500	1083000	MSE - IPC FS
Coarse Gravel Drainage Layer	92000	C.Y.	10	920000	ARCO Bid Tabulations
Filter Fabric (Geotextile)	114	Acres	4000	456000	Means
Cover Soil	122	Acres	4100	500200	ARCO Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				6293200	
Engineering / Construction Oversight (15%)				943980	
Subtotal Capital Costs				7237180	
Contingency (10%)				723718	
TOTAL CAPITAL COSTS				$7,960,898	

TABLE 6-8 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Estimate
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				29000	
Contingency (10%)				2900	
ANNUAL 30 YEAR O&M COST				$31,900	

TOTAL CAPITAL COSTS	7960898
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	490381
TOTAL PRESENT WORTH COST	**$8,451,279**

TABLE 6-9

PRELIMINARY COST ESTIMATE - ALTERNATIVE 7
VERTICAL GROUNDWATER BARRIERS WITH CAPPING AND INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Install Upgradient Slurry Wall	3600	L.F.	400	1440000	EPA
Install Upgradient GW Extraction Wells	36	Each	5000	180000	Engineering Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Construct Clark Tailings Cap	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				2677300	
Engineering / Construction Oversight (15%)				401595	
Subtotal Capital Costs				3078895	
Contingency (10%)				307890	
TOTAL CAPITAL COSTS				**$3,386,785**	

TABLE 6-9 Continued

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Electricity	105,000	kW-hr	0.07	7350	Estimate
Maintenance	1	L.S.	7000	7000	Estimate
Subtotal				33350	
Contingency (10%)				3335	
ANNUAL 30 YEAR O&M COST				**$36,685**	

TOTAL CAPITAL COSTS	3386785
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	563938
TOTAL PRESENT WORTH COST	**$3,950,723**

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TABLE 6-10

PRELIMINARY COST ESTIMATE - ALTERNATIVE 8
LANDFILL GAS REMOVAL WITH LOW PERMEABILITY CAPPING AND INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	30000	30000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Clark Tailings Infil. Barrier Layer	52	Acres	9000	468000	Bid Tabulations
Clark Tailings Capillary Break Layer	52	Acres	10000	520000	Bid Tabulations
Clark Tailings Cover Soil	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Install Passive Gas Venting	20	Acres	3100	62000	MDEQ, 1996
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				2037300	
Engineering / Construction Oversight (15%)				305595	
Subtotal Capital Costs				2342895	
Contingency (10%)				234290	

TABLE 6-10 Continued

TOTAL CAPITAL COSTS	**$2,577,185**

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				29000	
Contingency (10%)				2900	
ANNUAL 30 YEAR O&M COST				$31,900	

TOTAL CAPITAL COSTS	2577185
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	490381
TOTAL PRESENT WORTH COST	**$3,067,566**

TABLE 6-11

PRELIMINARY COST ESTIMATE - ALTERNATIVE 9
GROUNDWATER REMOVAL AND TREATMENT WITH CAPPING AND INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Install GW Extraction Wells/Pumps	11	Each	5000	55000	Engineering Estimate
Piping to Water Treatment Facility	1200	L.F.	45	54000	Experience
35 gpm Air Stripping Unit	3	Each	42000	126000	Am. Petroleum Inst.
100 gpm Ion Exchange Facility	1	L.S.	120000	120000	EPA, 1987
Discharge Piping/Structure	1	L.S.	25000	25000	Estimate
Acquire Discharge Permit	1	L.S.	50000	50000	Estimate
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Construct Clark Tailings Soil Cap	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate

TABLE 6-11 Continued

Subtotal	1487300
Engineering / Construction Oversight (15%)	223095
Subtotal Capital Costs	1710395
Contingency (10%)	171040
TOTAL CAPITAL COSTS	**$1,881,435**

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Air Stripping Unit Treatment Costs	1	L.S.	105000	105000	Am. Petroleum Inst.
Ion Exchange Unit Treatment Costs	1	L.S.	100000	100000	Estimate
Surface Water Discharge Sampling	12	Samples	1500	18000	Estimate
Cap Maintenance	1	L.S.	7000	7000	Estimate
Subtotal				249000	
Contingency (10%)				24900	
ANNUAL 30 YEAR O&M COST				**$273,900**	

TOTAL CAPITAL COSTS	1881435
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	4210514
TOTAL PRESENT WORTH COST	**$6,091,949**

TABLE 6-12

PRELIMINARY COST ESTIMATE - ALTERNATIVE 10
IN SITU GROUNDWATER TREATMENT WITH CAPPING AND INSTITUTIONAL CONTROLS

	Quantity	Units	Unit Price	Cost	Unit Cost Reference
CAPITAL COSTS					
Mobilization, Bonding, and Insurance	1	L.S.	100000	100000	Estimate
Install Air Sparging/SVE System	20	Acre	42400	848000	MDEQ, 1996
Install Gas Monitoring Wells	10	Each	2000	20000	Experience
Clark Tails Consolidation, Site Prep.	13000	cy	5	65000	Estimate
Construct Clark Tailings Soil Cap	52	Acres	7500	390000	Bid Tabulations
Construct Pre-1991 Landfill Cap	3	Acres	7500	22500	Bid Tabulations
Construct Post-1991 Landfill Cap	4	Acres	11700	46800	Bid Tabulations
Organic Amendment	122	Acres	500	61000	Schaefer
Fertilize, Seed, and Mulch	122	Acres	1500	183000	Schaefer
Lined Run-on Control Pond	1	L.S.	90000	90000	Estimate
Surface Water Diversions	5500	L.F.	8	44000	MDEQ Bid Tabulations
Institute Land Use Restrictions	1	L.S.	5000	5000	Estimate
Institute Controlled Groundwater Use Zone	1	L.S.	50000	50000	Estimate
Subtotal				1925300	
Engineering / Construction Oversight (15%)				288795	
Subtotal Capital Costs				2214095	
Contingency (10%)				221410	

TABLE 6-12 Continued

TOTAL CAPITAL COSTS	**$2,435,505**

POST CLOSURE MONITORING AND MAINTENANCE COSTS					
Inspections	2	/Year	500	1000	Estimate
Groundwater Monitoring - Sampling and Analysis	12	Samples	1500	18000	Experience
Air Sparging O&M	1	/Year	12200	12200	Am. Petroleum Inst.
Landfill Gas Monitoring	4	/Year	400	1600	Estimate
Maintenance	1	L.S.	10000	10000	Estimate
Subtotal				42800	
Contingency (10%)				4280	
ANNUAL 30 YEAR O&M COST				**$47,080**	

TOTAL CAPITAL COSTS	2435505
PRESENT WORTH, POST-CLOSURE MAINTENANCE AND MONITORING (5%)	723735
TOTAL PRESENT WORTH COST	**$3,159,239**

TABLE 6-13
ALTERNATIVE SCREENING SUMMARY

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 1: No Action	No additional action is taken at the site. Site would remain with landfill only partially capped and Clark Tailings cap partially eroding.	Protection of human health and the environment is not achieved. Not effective at satisfying landfill closure requirements.	Not applicable.	There is no cost associated with this alternative.	This alternative will be retained for comparison of other alternatives as suggested by the NCP.
Alternative 2: Institutional Controls	A fence would be installed around the site to prevent access. Land and groundwater use restrictions would be implemented.	Not effective at satisfying landfill closure regulations. Effective at reducing exposure to COCs.	Access restrictions implementable, but contradict with community's end use plans for the site. GWCA implementable through BSB Water Quality District and DNRC.	Present worth value of $513,614, includes $158,510 in capital costs and $23,100 in annual O&M costs.	This alternative will not be considered further as a stand alone alternative.
Alternative 3: Native Materials Capping	Native materials caps installed to satisfy landfill closure regulations. Run-on/run-off controls installed. Long-term groundwater monitoring would be implemented.	Effective at satisfying landfill closure regulations and preventing direct contact. Cap will decrease amount of surface water infiltration through wastes.	Technically and administratively feasible. Compatible with final use plans for the site.	Present worth value of $1,437,523, includes $1,065,510 in capital costs and $24,200 in annual O&M costs.	Alternative is implementable and potentially effective; however may not adequately address VOCs and will not prevent exposure. Therefore, it will be retained for further consideration.

TABLE 6-13
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 4: Native Materials Capping with Institutional Controls	Land and groundwater use restrictions implemented in addition to native materials cap described in Alternative 3.	Effective at satisfying landfill closure regulations. May not satisfy all regulations pertaining to closure of the Clark Tailings after the LAO materials are imported. Will reduce infiltration and leachate generation, but may not control landfill gases and VOC groundwater contamination.	Technically and administratively implementable. Materials are available locally. Applies conventional construction techniques. Implementation of controlled groundwater will require involvement of BSB Water Quality District and DNRC.	Present worth value of $1,574,737 includes $1,135,085 in capital costs and $28,600 in annual O&M costs.	Alternative is effective and implementable. While it may not achieve all regulatory standards, it will prevent exposure to COCs. It will be retained for further consideration.
Alternative 5: Low Permeability Capping with Institutional Controls	Native materials cap satisfying regulatory requirements installed over landfill portion of the site. A low permeability cap, satisfying closure regulations (ARM 17.50.530) installed over Clark Tailings. Land and groundwater use restrictions implemented.	Effective at satisfying closure regulations for the landfill and Clark Tailings portion of the site. Will reduce infiltration and leachate generation, but may not control landfill gases and VOC groundwater contamination.	Technically and administratively implementable. Materials are available locally. Applies conventional construction techniques. Implementation of controlled groundwater will require involvement of BSB Water Quality District and DNRC.	Present worth value of $2,989,136 includes $2,498,755 in capital costs and $31,900 in annual O&M costs.	Alternative is effective and implementable. It may not achieve GWPS for VOCs, but it will prevent exposure to COCs. It will be retained for further consideration.

TABLE 6-13
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 6: Multimedia Capping with Institutional Controls	A multimedia cap, consisting of native soils, a geosynthetic clay liner, and a flexible membrane liner would be installed to minimize infiltration through wastes. Institutional controls may also be implemented to control groundwater use.	Effective at preventing contact with COCs and minimizing surface water infiltration. Not certain if alternative would be effective at addressing groundwater contamination.	Technically and administratively implementable. Applies conventional materials and construction techniques.	Present worth value of $8,451,279 includes $7,960,898 in capital costs and $31,900 in annual O&M costs. Present worth rises to $8,015,000 if institutional controls are added.	Alternative is effective for inorganics, but not expected to be effective for VOCs. Therefore, due to effectiveness comparable to less expensive alternatives, this alternative will not be retained for further analysis.
Alternative 7: Vertical Groundwater Barriers with Capping and Institutional Controls	An upgradient slurry wall and hydrodynamic controls installed in addition to native soils cap and institutional controls.	Effectiveness of slurry wall uncertain. Soils cap and institutional controls effectiveness same as Alternative 4.	Cap and institutional controls implementable. Implementability of an effective slurry wall uncertain.	Present worth value of $3,950,723 includes $3,386,785 in capital costs and $36,685 in annual O&M costs.	Alternative's effectiveness and Implementability are questionable. Due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.

TABLE 6-13
ALTERNATIVE SCREENING SUMMARY (cont'd.)

ALTERNATIVE	DESCRIPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	SCREENING SUMMARY
Alternative 8: Landfill Gas Removal with Capping and Institutional Controls	Same as Alternative 5 with addition of passive gas vents installed over a portion of the landfill.	Gas venting expected to be effective at addressing VOC contamination. Capping and institutional controls will be effective at addressing inorganic contamination. Will satisfy all regulatory requirements.	Technically feasible and readily implementable. Uses conventional technology and readily available materials construction expertise. Alternative is conducive with future land use plans.	Present worth value of $3,067,566 includes $2,577,185 in capital costs and $31,900 in annual O&M costs.	This alternative is expected to be effective and implementable. Therefore, it will be retained for detailed analysis.
Alternative 9: Groundwater Removal and Treatment with Capping and Institutional Controls	Same as Alternative 4 with addition of groundwater removal (via extraction pumps) and treatment (via air stripping and ion exchange).	Capping and institutional controls will be effective at controlling inorganics, but may not satisfy all regulatory requirements. Groundwater removal not expected to be effective because of heterogeneous aquifer setting.	Technically implementable. Discharge of water will require a MPDES permit.	Present worth value of $6,091,949 includes $1,881,435 in capital costs and $273,900 in annual O&M costs.	Effectiveness is questionable. Due to high cost and uncertain effectiveness, this alternative will not be retained for further analysis.
Alternative 10: In Situ Groundwater Treatment with Capping and Institutional Controls	Same as Alternative 4 with addition of in situ groundwater treatment via air sparging.	Capping and institutional controls will address inorganics, and air sparging will be effective at controlling VOCs. Capping may not satisfy all regulatory requirements.	Technically and administratively implementable. However, air sparging may exacerbate landfill gas migration.	Present worth value of $3,159,239 includes $2,435,505 in capital costs and $47,080 in annual O&M costs.	Alternative is potentially effective and implementable. However, air sparging may lead to landfill gas migration problems. Also, no more effective than other alternatives that are less costly more easily implemented. Therefore, this alternative will not be retained for further analysis.

ATTACHMENTS
1 THROUGH 4

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES
Waste Management Division
Solid Waste Program
406/444-1430
FAX # (406) 444-1499

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA
MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

December 23, 1994

Gary Keeler
Landfill Manager
Butte-Silver Bow County
Courthouse
Butte, MT 59701

Dear Gary:

The Department has received the assessment monitoring test results (Table 2) from the Old Butte Landfill. The cover letter from Pioneer Technical Services indicates that the last of the organic data was received on December 1, 1994. The Department will use that date for the start of the next required sequence of events even though knowledge of the exceedance of the ground water protection standard for thallium was known earlier to Pioneer. They were apparently not knowledgable of the requirements of ARM 16.14.708(4) which requires Department notification within 14 days of the discovery.

The detection of Table 2 constituents above the ground water protection standard triggers a series of events with specific deadlines. The first requirement is stated in ARM 16.14.708(1)(a)(iv):

> For any constituent detected in the downgradient wells as a result of the complete Table 2 analysis, collect and analyze a minimum of four independent samples from each well (downgradient and upgradient) to establish background for the constituents detected;

The landfill must continue assessment monitoring as specified in ARM 16.14.708(1)(a)(v). During continued assessment monitoring the owner or operator must:

(A) Sample all wells for all Table 2 constituents at least annually;

(B) Sample all wells within 90 days and at least semi-annually thereafter for all Table 1 constituents and all Table 2 constituents detected in the initial, or subsequent annual, Table 2 sampling; and

(C) Collect and analyze at least one sample from each well (background and downgradient) during each sampling event.

(D) For any constituent detected in the downgradient wells as a result of the Table 2 analysis, collect and analyze a minimum of

four independent samples from each well (downgradient and upgradient) to establish background for the constituents detected;

Based on recent correspondence with the EPA, the initial Table 2 sampling and the previous Table 1 sampling can be used to count toward the four required samples. Thus if an analyte was detected in both events, only two re-samples for that analyte are needed. If a substance was only on the Table 2 list, then three samples are needed. The EPA suggests that to maintain independence of the samples, 30 days should elapse between sampling events. The landfill should thus sample the wells around the first of January and the first of February for the Table 2 detects and the first of March for the Table 2 detects and Table 1 constituents, as required by (B) above.

While this sampling is going on, ARM 16.14.708(4) specifies that a landfill which has exceeded a ground water protection standard:

> "(a)(i) Must characterize the nature and extent of the release by installing additional monitoring wells as necessary;
> (ii) Must install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well for all Table 2 constituents;
> (iii) Must notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site if indicated by sampling of wells; and
> (iv) Must initiate an assessment of corrective measures within 90 days;".

In order to do an assessment of corrective measures, it is necessary to determine the extent of the problem. Please contact the Department promptly so that we can come to an understanding on the number of additional monitoring wells that may be required at this facility. The Department may be able to provide some additional technical assistance on the ground water flow in the area based on information developed for Superfund sites in Butte.

ARM 16.14.708(6)(a) requires:

> Within 90 days of finding that any of the constituents listed in Table 2 (ARM 16.14.706) have been detected at a statistically significant level exceeding the ground water protection standards defined under (5) of this rule, the owner or operator must initiate an assessment of corrective measures. Such an assessment must be completed within a reasonable period of time, not to exceed an additional 60 days, and be submitted to the department.

The corrective measures assessment must be initiated by March 1, 1995 and completed by April 30, 1995.

I would like to refer you to the requirements of ARM 16.14.708(6) which discusses the assessment of corrective measures, including the need to hold a public hearing prior to selection of remedy; ARM 16.14.708(7), which discusses remedy requirements; and ARM 16.14.708(8), which discusses implementation of the remedy, interim protection measures, and completion schedules; rather than quote the entire sections of the rules.

You should be aware that discussions are currently underway to decide whether the remediation of the Old Butte Landfill and the Clark Tailings should be handled under federal Superfund (CERCLA) or this program. That both the Clark Tailings and Old Butte Landfill should be remediated as "one facility" is not in dispute and in fact has been requested by officials representing Butte-Silver Bow and the Atlantic Richfield Company (ARCO). Which program assumes final authority for corrective action does not set aside current requirements for the assessment of corrective measures at the landfill. Regardless of which program assumes remediation authority, all future corrective action should be broadened to include and take into consideration the entire facility (i.e., Old Butte Landfill and Clark Tailings).

We realize the time deadlines are short; however, we will work with you to assure compliance in a timely fashion. If you have any further questions on this matter, please contact me.

Sincerely,

F. Patrick Crowley

F. Patrick Crowley
Solid Waste Regulatory Lead

cc: Jimmy Johnson, DPW, Butte-Silver Bow

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DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENC
DIRECTOR'S OFFICE

Jon Sesso
Dan Dennehy
Tim Johnston

STATE OF MONTANA

(406) 444-2544 (OFFICE)
(406) 444-1804 (FAX)

HELENA, MONTANA 59620-0901

RECEIVED
MAR 27 1995

March 23, 1995

Mr. Jack Lynch
Butte-Silver Bow County
155 West Granite Street
Butte, Montana 58701

Dear Mr. Lynch: Jack

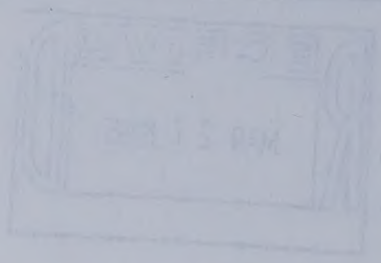
At a number of meetings over the past several months, Butte-Silver Bow County (BSB), the Montana Department of Health and Environmental Sciences (MDHES), the U.S. Environmental Protection Agency (EPA), and several potentially responsible parties have discussed the possibility of integrating the cleanup of the Clark Tailings with the closure of the old Butte-Silver Bow landfill. Butte-Silver Bow has suggested that a combined cleanup be conducted under RCRA authorities under the supervision and direction of the MDHES Solid Waste Program.

MDHES agrees with the proposed approach provided that the following conditions are met to insure that the cleanup of both parts of this site can be completed in an efficient, timely, cost-effective, and thorough manner:

1. Butte-Silver Bow needs formally to commit to completing the cleanup action for those areas of the combined action that are physically outside of the present boundaries of the Butte-Silver Bow Landfill. This is necessary because the regulatory authority of the Solid Waste Program, under RCRA, is limited to the actual landfill property. The commitment could take the form of a memorandum of agreement or letter signed jointly by BSB and MDHES. Failure to complete the necessary action for the Clark Tailings portion of the site would revert that cleanup to the EPA Superfund program.

2. The MDHES Superfund Program will provide staff and technical support to the Solid Waste Program to help deal with the Clark Tailings portion of the site. That support will be provided through EPA cooperative agreement funding which will ultimately be cost recovered by EPA from the Priority Soils PRPs. We understand that EPA is also willing to provide direct support from its technical contractor.

3. BSB will commit to evaluating an appropriate range of alternatives consistent with the landfill closure requirements under RCRA prior to the selection of a final cleanup and closure option. Methods to prevent the spread of groundwater contamination will



need to be considered. Although it is appropriate to consider likely future uses of the property, for instance, recreational use, in evaluating alternatives, the basis for determining future uses should be clearly identified and documented.

4. BSB will need to involve the public fully in the evaluation and selection of corrective action and closure options for the combined site.

If the 1995 legislature substantially reduces the funding or staffing levels for the MDHES Solid Waste Program, then the Department may not be able to oversee the cleanup in an efficient manner. We would probably have to request that the Clark Tailings portion of the site revert to EPA Superfund authorities in that case.

Please feel free to contact either me or Pat Crowley of our Solid Waste Program regarding this action.

Sincerely,

Robert J. Robinson
Director

cc: John Wardell, EPA
Jim Scott, MDHES
Pat Crowley, MDHES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII, MONTANA OFFICE
FEDERAL BUILDING, 301 S. PARK, DRAWER 10096
HELENA, MONTANA 59626-0096

Attachment 3

Ref: 8MO

March 1, 1995

Mr. Jack Lynch
Chief Executive
Butte-Silver Bow.
155 West Granite St.
Butte, Montana 58701

Dear Jack:

We have discussed on several occasions ways to speed the cleanup of the Clark Tailings by integrating that cleanup with the closure of the Butte-Silver Bow landfill. Recent staff level discussions among Butte-Silver Bow, EPA and the State have shown there is a common desire to initiate this integrated cleanup using the authorities contained in the RCRA law. By this letter, EPA endorses this proposal and stands ready to assist in this effort.

EPA believes it makes sense to implement an integrated cleanup/closure because the tailings are partially intermixed with the landfill and because the contaminants associated with the tailings and the landfill are also intermixed. Any remedy will have to deal with these contaminants as a combined source. We are confident that the technical RCRA requirements for landfill closure would be appropriate for containing the Clark Tailings. EPA would be willing to provide contractor technical assistance to the State RCRA staff to the extent that RCRA staff may need assistance in dealing with wastes normally handled under CERCLA (the Clark Tailings). It should be noted that if there is a failure to comply with the requirements under RCRA, the Clark Tailings cleanup would revert to the jurisdiction of CERCLA.

I believe this integrated cleanup approach using all available legal authorities is a good step in streamlining the Superfund cleanup process. We look forward to rapid progress on this project.

Please contact me if you have any questions or concerns about this issue.

Sincerely,

John F. Wardell,
Montana Office Director

cc: Bob Robinson

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END

Attachment 4

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

Waste Management Division
Solid Waste Management Program
406/444-1430

FAX # (406) 444-1902

STATE OF MONTANA

OFFICE LOCATION: 2209 PHOENIX AVE. HELENA, MONTANA

MAILING ADDRESS: PO BOX 200901 HELENA, MT 59620-0901

RECEIVED
FEB 3 1995

February 2, 1995

Mr. James Johnston
Department of Public Works
Butte-Silver Bow County
Butte-Silver Bow County Courthouse
155 West Granite
Butte, Montana 59701

Subject: Old Butte-Silver Bow Landfill, License #20, Temporary C&D Disposal Site

Dear Jimmy:

I would like to thank you and Mike Shea for taking the time to meet with me and other program staff to discuss the possibility of using the old Butte-Silver Bow Landfill as a temporary construction and demolition (C&D) disposal area. Based on the Program's review of the conditions and operational modifications you submitted for the conversion, the Program believes that the idea is workable and appropriate. However, as we discussed during our meeting there are a few additional changes and conditions we need to request to make the temporary disposal area approvable. Below I have listed and discuss these additions:

1. The C&D wastes must be covered with six inches of earthen cover material on a bi-weekly basis at a minimum. More frequent cover will be required if litter, insect, or rodent harborage become problems. The Program also strongly recommends the consideration of alternative daily cover materials for covering the waste on a daily basis. Since C&D waste does contain components that may leach out toxic materials if exposed to water, it is our concern that the wastes do not become saturated while exposed. The old Butte-Silver Bow Landfill is already experiencing possible ground water contamination problems and it would be unfortunate to have this area add to the problems. Another reason for the consideration of ADC is the high frequency of gypsum found in C&D wastes. When gypsum board becomes wet and starts to decompose it releases hydrogen sulfide gas. This gas can be highly toxic to humans if inhaled in sufficient dosage. The use of ADC would help to keep moisture out of the waste and prevent or reduce the generation of this gas.

2. Many fixtures in a building contain significant sources of contaminants that can be released into the environment on disposal. Examples include: lights and light fixtures (mercury and PCB oils), carpets (formaldehyde and other VOCs), and copper and lead piping (metals).

To help eliminate potential impacts to the environment from this type of material in the exposed C&D wastes, the Program requests that lights, light fixtures, carpets, and metal piping be removed from the buildings to the greatest extent possible prior to demolition and delivery to the disposal site. The removed materials can be reused, recycled, or disposed of in the new Butte-Silver Bow Class II Landfill.

3. Since the use of the proposed area for C&D disposal was not anticipated in the original closure plan and surface water run-on/run-off plans for this landfill, the use of the site in this manner will ultimately need to be addressed in these plans. Changes in the final topographic contours, drainage pathways and controls of the closure plan will need to be made to the plan on file with the Department. This should be accomplished as soon as possible because the needs of the closure plans may dictate where and how high disposal of C&D wastes can occur in the proposed area.

4. As a separate but related issue, plans for the development of a methane gas monitoring system for the landfill will need to be addressed in the very near future. Since the landfill was unable to complete closure by October, 1994, and since the site will be continuing to receive wastes for a temporary period, a system to monitor for the generation and possible migration off site of explosive gases is needed. Such a system need not be expensive or complicated and may be able to be worked into future activities concerning the groundwater contamination and closure of the site.

In consideration of the operations plan changes you submitted to the Program on January 24, 1995, and with understanding and agreement on the above listed additional conditions as we discussed in our meeting, your plans to operate a temporary construction and demolition disposal area at the old Butte-Silver Bow Landfill, License #20, is approved. Please contact the Program with a proposed schedule for the opening of the site and the hours of operation as soon as they are available.

Thank you for your cooperation in this matter. Please do not hesitate to contact me or other staff members of the Program if you have any questions.

Sincerely,

Jon A. Dilliard

cb5415\wp\sw\ltr95\Johnston.127

APPENDIX A

GROUNDWATER MONITORING DATA

MBMG-2 GROUNDWATER MONITORING DATA

	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	8 / 95	2 / 96
DISSOLVED METALS (mg/L)								
Antimony		<0.002	NA	0.004 F	0.009 F	0.004 F	<0.002	<0.003
Arsenic	<0.005	0.002	NA	0.002	0.003	<0.001	0.01	0.001
Barium	0.2	0.133	NA	0.142	0.136	0.132	0.117	0.138
Berrylium		<0.003	NA	<0.001	<0.001	0.002 F	0.0002	<0.0001
Cadmium	<0.001	0.0003	NA	<0.0001	<0.0001	0.0004	0.0002	<0.0001
Chromium	<0.01	<0.007	NA	0.009	<0.009	<0.009	<0.010	0.009
Cobalt		<0.009	NA	<0.010	<0.010	<0.010	<0.01	<0.01
Copper		<0.007	NA	<0.002	<0.002	0.008 F	<0.004	<0.003
Iron	1.89	<0.013	NA	0.015	0.055	0.222	0.119	0.935
Lead	<0.01	<0.001	NA	<0.001	<0.001	<0.001	0.002	<0.001
Mercury	<0.001	<0.0002	NA	<0.0001	<0.0001	0.0002	<0.0002	0.0001
Nickel		<0.015	NA	<0.02	<0.01	<0.01	<0.01	<0.01
Selenium	<0.005	0.001	NA	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.005	<0.004	NA	<0.002	<0.0004	<0.0004	<0.0004	<0.004
Thallium		<0.001	NA	0.006	0.006 F	0.005	0.007	<0.001
Vanadium		0.012	NA	0.010 F	0.006	0.013	0.008	0.012
Zinc		<0.007	NA	<0.01	0.03	0.02	<0.008	<0.009
INORGANICS (mg/L)								
Cyanide	<0.005	<0.005	NA	NR	NR	NR	<0.005	NR
Conductivity (umhos/cm)	714	742	NA	676	700	701	675	753
Chloride	52	64	NA	57	57	61	57	56
Sulfate	124	134	NA	136	123	136	120	147
Sulfide	NR	NR	NA	NR	NR	NR	<1.5	NR
COD	<1	<20	NA	25	48	80	244	94
Nitrate\Nitrite - N	5.9	5.5	NA	4.88	3.99	5.17	6.25	7.23
EPA METHOD 8260 (ug/L) (METHOD 8240 ON 4/93)								
Acetone		<50	NR	<50	<50	<50(40J)	<50(14JB)	<50
Benzene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon Disulfide		<1.0 (0.75J)	NR	1.2 F	<1.0 (0.99J)	<1.0	<1.0	<1.0
Chloroform		<1.0 (0.75J)	NR	<1.0 (0.84J)	<1.0 (0.98J)	<1.0 (0.81J)	<1.0 (0.78J)	<1.0 (0.82J)
Chloroethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane		<1.0 F	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane		<1.0 F	NR	<1.0	<1.0	<1.0	<1.0	<1.0 (0.48J)
1,1-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone		<20	NR	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorofluoromethane		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
m+p Xylenes		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene		<1.0	NR	<1.0	<1.0	<1.0	<1.0	<1.0
EPA METHOD 8151 (ug/L)								
2,4 - D		NR	NR	NR	NR	NR	<1.0	<1.0
Dacthal		NR	NR	NR	NR	NR	<1.0	<1.0
4-Nitrophenol		NR	NR	NR	NR	NR	<0.50	<0.50 (0.30J)
Picloram		NR	NR	NR	NR	NR	0.50 (0.096J	<0.50 (0.21J)
2,4,5 - TP (Silvex)		NR	NR	NR	NR	NR	<0.20	<0.20
EPA METHOD 8270 (ug/L)								
1,4-Dichlorobenzene	NA	NA	NA	<10	<11	<10	<11	<10
Diethylphthalate	NA	NA	NA	<10	<11	<10	<11	<10
Di-n-Butylphthalate	NA	NA	NA	<10	<11	<10	<11	<10
bis(2-ethylhexyl) Phthalate	NA	NA	NA	<10	<11	<10	<11	<10
2-Methylphenol	NA	NA	NA	<10	<11	<10	<11	<10
4Methylphenol/3Methylphenol	NA	NA	NA	<10	<11	<10	<11	<10
Phenol	NA	NA	NA	<10	<11	<10	<11	<10

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

BSB-A1 GROUNDWATER MONITORING DATA

	4/93	2/94	8/94	1/95	2/95	3/95	8/95	2/96
DISSOLVED METALS (mg/L)								
Antimony		<0.002	<0.002	0.006 F	0.007 F	<0.003	0.002	<0.003
Arsenic	0.014	0.004	<0.002	0.002	0.003	<0.001	0.002	<0.001
Barium	0.2	0.122	0.122	0.081	0.081	0.072	0.076	0.076
Berryllum		<0.003	<0.001	<0.001	<0.001	0.0002 F	0.0003	<0.0001
Cadmium	<0.001	0.0007	<0.004	0.0003	0.0001	0.0001	0.0002	<0.0001
Chromium	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.010	0.014
Cobalt		<0.009	<0.008	<0.010	<0.010	<0.010	<0.010	<0.010
Copper		<0.007	<0.006	<0.002	<0.002	0.005 F	<0.004	<0.003
Iron	12.5	0.022	<0.01	0.026	0.080	<0.013	0.025	0.021
Lead	0.05	0.002	<0.001	<0.001	<0.001	0.002	<0.001	<0.001
Mercury	<0.001	<0.0002	0.0003	<0.0001	<0.0001	<0.0001	<0.0002	0.0001
Nickel		<0.015	<0.014	<0.02	<0.01	<0.01	<0.01	<0.01
Selenium	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.005	<0.004	<0.004	<0.002	<0.0004	<0.0004	<0.001	<0.004
Thallium		<0.001	0.005	0.007	0.005 F	0.005	0.007	<0.001
Vanadium		<0.009	<0.009	0.004 F	<0.004	<0.004	<0.006	<0.004
Zinc		0.017	<0.016	<0.01	0.02	0.01	0.013	<0.009
INORGANICS (mg/L)								
Cyanide	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	NR
Conductivity (umhos/cm)	581	591	654	450	418	426	473	466
Chloride	35	20	17	15	14	15	15	16
Sulfate	112	148	176	100	85	84	103	88
Sulfide	NR	NR	<1.5	NR	NR	NR	<1.5	NR
COD	<1	33	44	47	28	131	138	88
Nitrate\Nitrite - N	0.29	<0.05	0.61	0.46	0.68	0.64	0.63	0.56
EPA METHOD 8260 (ug/L)								
(METHOD 8240 ON 4/93)								
Acetone		<50	73 F	<50	<50	<50	<50(4.6JB)	<50
Benzene		<1.0 (0.19J)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon Disulfide		<1.0	0.85J F	0.61J F	<1.0	<1.0	<1.0	<1.0
Chloroform		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane		0.83J F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane		<1.0	<1.0 (0.40J)	<1.0 (0.15J)	<1.0	<1.0	<1.0	<1.0
Dichlorofluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane		1.2 F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.46J)
1,1-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		<1.0	<1.0 (0.74J)	<1.0 (0.39J)	<1.0	<1.0	<1.0 (0.28J)	<1.0
trans-1,2-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<20
Ethyl Benzene	<1.0J	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone		<20	<20	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		1.8	3.3	1.6	<1.0 (0.59J)	<1.0 (0.75J)	2.1	<1.0 (0.63J)
1,1,1-Trichloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0J	<1.0	0.54J F	<1.0	<1.0 (0.11J)	<1.0	<1.0	<1.0
Trichloroethene		<1.0 (0.40J)	<1.0 (0.72J)	<1.0	<1.0	<1.0	<1.0 (0.39J)	<1.0
Trichlorofluoromethane		<1.0	<1.0 (0.18J)	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m+p Xylenes	2.5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
EPA METHOD 8151 (ug/L)								
2,4 - D		NR	NR	NR	NR	NR	<1.0	<1.0
Dacthal		NR	NR	NR	NR	NR	<1.0	<1.0
4-Nitrophenol		NR	NR	NR	NR	NR	<0.50	<0.50
Picloram		NR	NR	NR	NR	NR	<0.50	<0.50
2,4,5 - TP (Silvex)		NR	NR	NR	NR	NR	<0.20	<0.20
EPA METHOD 8270 (ug/L)								
1,4-Dichlorobenzene	NA	NA	<10	<10	<11	<10	<10	<10
Diethylphthalate	NA	NA	<10	<10	<11	<10	<10	<10
Di-n-Butylphthalate	NA	NA	<10	<10	<11	<10	<10	<10
bis(2-ethylhexyl) Phthalate	NA	NA	<10	<10 (0.91J)	<11	<10	<10 (2.7JB)	<10
2-Methylphenol	NA	NA	<10	<10	<11	<10	<10	<10
4Methylphenol/3Methylphenol	NA	NA	<10	<10	<11	<10	<10	<10
Phenol	NA	NA	<10	<10	<11	<10	<10	<10

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

BSB-A2 GROUNDWATER MONITORING DATA

	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	8 / 95	2 / 96
DISSOLVED METALS (mg/L)								
Antimony		<0.002	0.005	0.003 F	<0.003	0.005 F	0.004	0.004
Arsenic	<0.005	0.004	0.008	0.012	0.011	0.012	0.008	0.013
Barium	0.2	0.040	0.058	0.075	0.085	0.080	0.074	0.077
Berrylium		<0.003	<0.001	<0.001	0.002	0.0001 F	0.0002	<0.0001
Cadmium	<0.001	0.0231	0.01	0.0023	0.0013	0.0013	0.083	0.0425
Chromium	<0.01	0.007	<0.007	<0.008	<0.009	<0.009	<0.010	0.017
Cobalt		0.032	0.023	0.019	0.012	<0.010	0.02	<0.010
Copper		<0.007	<0.006	<0.002	<0.002	0.002 F	<0.004	<0.003
Iron	4.51	0.729	4.12	8.81	10.4	8.21	5.72	11.5
Lead	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	<0.001	<0.0002	0.0001	<0.0001	<0.0001	<0.0001	<0.0002	<0.0001
Nickel		0.090	<0.014	0.02	<0.01	0.03	<0.01	<0.01
Selenium	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.005	<0.004	<0.004	0.004	<0.0004	<0.0004	<0.001	0.006
Thallium		<0.001	0.005	0.006	0.006 F	0.010	0.008	<0.001
Vanadium		<0.009	<0.009	<0.004 F	<0.004	<0.004	0.006	<0.004
Zinc		18.9	7.65	2.09	1.39	1.49	26.3	24.3
INORGANICS (mg/L)								
Cyanide	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	NR
Conductivity (umhos/cm)	1330	1980	1650	1650	1710	1620	1640	1620
Chloride	109	128	140	126	117	120	119	120
Sulfate	116	664	218	198	288	181	276	1891
Sulfide	NR	NR	<1.5	NR	NR	NR	<1.5	NR
COD	<1	243	443	21	109	115	235	115
Nitrate\Nitrite - N	<0.05	<0.05	<0.05	<0.05	0.09	0.09	0.05	0.09
EPA METHOD 8260 (ug/L) (METHOD 8240 ON 4/93)								
Acetone		<50	<50 F	<50	<50	<50	<50	<50
Benzene		<1.0 (0.89J)	1.6	1.5	1.6	1.4	1.1	2.2
Carbon Disulfide		1.5	<1.0 F	0.12J F	<1.0 (0.12J)	<1.0	<1.0	<1.0
Chloroform		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane		2 F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0 (0.74J)	<1.0	<1.0 (0.75J)
1,4-Dichlorobenzene		1.7	3.3	4.2	4.8	4.7	3.9	5.1
Dichlorodifluoromethane	27 D	16	18	20 D	27 D1	23 D	23 D	16 D
Dichlorofluoromethane		15	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	9.8	6.6	12	13	14	14	12	18
1,2-Dichloroethane	1.4	4.9 F	2	2.0	1.8	<1.0	1.6	2.5
1,1-Dichloroethene		<1.0 (0.33J)	<1.0 (0.51J)	<1.0 (0.50J)	<1.0 (0.58J)	<1.0 (0.53J)	<1.0	<1.0 (0.58J)
cis-1,2-Dichloroethene		91	180 D	160 D	196 D2	156 D	135 D	185 D
trans-1,2-Dichloroethene		<1.0 (0.94J)	1.3	1.5	1.7	1.5	1.2	1.7
1,2-Dichloropropane		1.4	2.2	2.3	2.2	2.3	2.3	3.0
Ethyl Benzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.18J)
Methyl Ethyl Ketone		<20	<20	<20	<20	<20	<20	<20 (3.0J)
Methyl Isobutyl Ketone		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride		1.8	1.8	1.4	1.6	2.0	<1.0 (0.44J)	1.3
Tetrachloroethene	8.0	6.9	6.4	6.1	6.9	7.4	6.4	6.8
1,1,1-Trichloroethane		8.8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene		<1.0	<1.0 F	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	20	14	14	14	15	16	15	13
Trichlorofluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride		<1.0	3.9	3.8	4.1	3.6	<1.0	3.5
m+p Xylenes		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.16J)
o-Xylene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
EPA METHOD 8151 (ug/L)								
2,4 - D		NR	NR	NR	NR	NR	<1.0	<1.0
Dacthal		NR	NR	NR	NR	NR	<1.0 (0.17J)	<1.0
4-Nitrophenol		NR	NR	NR	NR	NR	<0.50	<0.50
Picloram		NR	NR	NR	NR	NR	<0.50 (0.48J)	<0.50
2,4,5 - TP (Silvex)		NR	NR	NR	NR	NR	0.66	<0.20
EPA METHOD 8270 (ug/L)								
1,4-Dichlorobenzene	NA	NA	<10 (2.8J)	<10 (2.3J)	<10 (3.1J)	<10 (3.0J)	<10 (2.2J)	<10 (2.0J)
Diethylphthalate	NA	NA	<10 (2.4J)	<10 (1.3J)	<10 (1.7J)	<10 (3.8J)	14	12
Di-n-Butylphthalate	NA	NA	<10 (0.70JB)	<10	<10	<10	<10	<10
bis(2-ethylhexyl) Phthalate	NA	NA	<10 (1.4JB)	<10 (0.79J)	<10	<10	<10 (1.4J)	<10
2-Methylphenol	NA	NA	<10	<10	<10	<10	<10	<10
4Methylphenol/3Methylphenol	NA	NA	<10	<10	<10	<10	<10	<10
Phenol	NA	NA	<10	<10	<10	<10	<10	<10

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

BSB-A3 GROUNDWATER MONITORING DATA

	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	8 / 95	2 / 96
DISSOLVED METALS (mg/L)								
Antimony		<0.002	<0.002	0.003 F	0.005 F	<0.003	0.002	0.014
Arsenic	0.008	0.015	0.025	0.044	0.042	0.047	0.036	0.039
Barium	0.5	0.077	0.117	0.171	0.192	0.176	0.229	0.379
Berryilum		<0.003	<0.001	<0.001	<0.001	0.0001 F	0.0002	<0.0001
Cadmium	0.003	0.0002	<0.004	<0.0001	0.0001	0.0001	<0.0001	<0.0001
Chromium	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.010	0.02
Cobalt		0.022	<0.008	<0.010	<0.010	<0.010	<0.010	<0.010
Copper		<0.007	<0.006	<0.002	<0.002	0.002 F	<0.004	<0.003
Iron	29.5	50.9	68.9	92.3	82.0	84.6	81.1	94.3
Lead	<0.01	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Mercury	<0.001	<0.0002	0.0003	<0.0001	<0.0001	0.0002	0.0002	<0.0001
Nickel		<0.015	<0.014	<0.02	<0.01	<0.01	<0.01	<0.01
Selenium	<0.005	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.005	<0.004	<0.004	0.004	<0.0004	<0.0004	<0.001	0.005
Thallium		0.002	0.006	0.007	0.021 F	0.008	0.008	<0.001
Vanadium		<0.009	<0.009	0.007 F	<0.004	<0.004	<0.006	<0.004
Zinc		0.918	0.155	0.03	0.09	0.04	0.113	0.156
INORGANICS (mg/L)								
Cyanide	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	NR
Conductivity (umhos/cm)	1190	1100	1170	1190	1010	1150	1060	1050
Chloride	24	55	49	42	40	37	46	57
Sulfate	68	130	77	49	51	39	48	95
Sulfide	NR	NR	<1.5	NR	NR	NR	<1.5	NR
COD	<1	79	94	60	92	169	127	69
Nitrate\Nitrite - N	<0.05	<0.05	<0.05	<0.05	0.05	39	0.05	<0.05
EPA METHOD 8260 (ug/L)								
(METHOD 8240 ON 4/93)								
Acetone		<50	127 F	<50	<50	<50	72 B	<50
Benzene	1.1	2.1	1.8	3.4	3.7	3.6	1.2	1.2
Carbon Disulfide		1.4	<1.0 F	<1.0 F	<1.0 (0.12J)	<1.0	<1.0	<1.0 (0.86J)
Chloroform		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0 (0.86J)	1.3	1.4	1.1	<1.0	<1.0
Chloromethane		<1.0 F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene		1.9	3.7	5.1	5.1	4.8	3.0	2.1
Dichlorodifluoromethane	2.0	<1.0	1.1	1.5	1.6	1.6	23 D	<1.0 (0.35J)
Dichlorofluoromethane		<1.0 (0.88J)	<1.0	<1.0	<1.0	<1.0		<1.0
1,1-Dichloroethane	3.8	1.1	1.2	<1.0 (0.99J)	1.1	1.1	<1.0 (0.76J)	1.2
1,2-Dichloroethane		3.3 F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.51J)
1,1-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		36	38 D	53 D	60 D	57 D	33 D	31 D
trans-1,2-Dichloroethene		<1.0	<1.0	<1.0 (0.26J)	<1.0 (0.30J)	<1.0 (0.25J)	<1.0	<1.0 (0.15J)
1,2-Dichloropropane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene		5.8	2.2	1.6	<1.0 (0.79J)	<1.0 (0.87J)	1.7	1.8
Methyl Ethyl Ketone		<20	<20	<20	<20	<20	70	<20 (3.1J)
Methyl Isobutyl Ketone		<1.0	<1.0	<1.0	<1.0	<1.0	<20 (2.3J)	<1.0
Methylene Chloride		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		<1.0 (0.26J)	<1.0 (0.55J)	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane		3.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene		<1.0	<1.0 F	<1.0	<1.0 (0.18J)	<1.0 (0.16J)	3.3	<1.0
Trichloroethene	1.1	1.4	1.8	1.0	1.0	1.1	1.5	<1.0 (0.83J)
Trichlorofluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<1.0J	<1.0	<1.0	1.3	1.2	1.2	<1.0	<1.0 (0.68J)
m+p Xylenes		1	<1.0 (0.62J)	1.4	1.1	<1.0 (0.74J)	<1.0 (0.86J)	1.2
o-Xylene		<1.0	<1.0	<1.0 (0.26J)	<1.0 (0.14J)	<1.0 (0.14J)	<1.0 (0.37J)	<1.0 (0.13J)
EPA METHOD 8151 (ug/L)								
2,4 - D		NR	NR	NR	NR	NR	<1.0	<1.0
Dacthal		NR	NR	NR	NR	NR	<1.0	<1.0
4-Nitrophenol		NR	NR	NR	NR	NR	<0.50	<0.50
Picloram		NR	NR	NR	NR	NR	0.50 (0.083J	<0.50
2,4,5 - TP (Silvex)		NR	NR	NR	NR	NR	<0.20 (0.15J)	<0.20
EPA METHOD 8270 (ug/L)								
1,4-Dichlorobenzene	NA	NA	<10 (2.2J)	<10 (3.0J)	<11 (2.3J)	<10 (3.0J)	<10 (1.7J)	<10 (0.55J)
Diethylphthalate	NA	NA	<10 (1.4J)	<10 (2.1J)	<11	<10	<10 (3.6J)	<10 (3.8J)
Di-n-Butylphthalate	NA	NA	<10	<10	<11	<10	<10 (0.53J)	<10
bis(2-ethylhexyl) Phthalate	NA	NA	<10	<10	<11	<10	<10	<10
2-Methylphenol	NA	NA	<10	<10	<11	<10	<10 (1.1J)	<10
4Methylphenol/3Methylphenol	NA	NA	<10	<10	<11	<10	62	<10
Phenol	NA	NA	<10	<10	<11	<10	<10 (7.5J)	<10

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

BSB-A4 GROUNDWATER MONITORING DATA

	4 / 93	2 / 94	8 / 94	1 / 95	2 / 95	3 / 95	8 / 95	2 / 96
DISSOLVED METALS (mg/L)								
Antimony		<0.002	<0.002	0.005 F	0.006 F	0.003 F	0.002	<0.003
Arsenic	<0.005	0.004	0.002	0.003	0.004	0.002	0.003	0.001
Barium	0.1	0.043	0.033	0.031	0.044	0.031	0.027	0.027
Berrylium		<0.003	0.001	<0.001	<0.001	0.0001 F	0.0003	0.0001
Cadmium	0.002	<0.0001	<0.004	<0.0001	0.0001	0.0001	<0.0001	0.0001
Chromium	<0.01	<0.007	<0.007	<0.008	<0.009	<0.009	<0.010	0.008
Cobalt		<0.009	<0.008	<0.010	<0.010	<0.010	<0.010	<0.010
Copper		<0.007	<0.006	<0.002	<0.002	0.009 F	<0.004	<0.003
Iron	0.04	<0.013	<0.01	<0.009	<0.013	<0.013	0.079	<0.016
Lead	<0.01	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.001
Mercury	<0.001	0.0002	0.0003	<0.0001	<0.0001	0.0002	<0.0002	<0.0001
Nickel		<0.015	<0.014	<0.02	<0.01	<0.01	<0.01	<0.01
Selenium	<0.005	0.003	0.003	0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.005	<0.004	<0.004	<0.002	<0.0004	<0.0004	<0.001	<0.004
Thallium		<0.001	0.006	0.005	0.005 F	0.003	0.007	<0.001
Vanadium		<0.009	<0.009	0.009 F	0.006	0.007	0.007	0.004
Zinc		<0.007	<0.016	<0.01	0.03	<0.01	0.009	<0.009
INORGANICS (mg/L)								
Cyanide	<0.005	<0.005	<0.005	NR	NR	NR	<0.005	NR
Conductivity (umhos/cm)	1450	758	627	573	586	580	501	484
Chloride	276	21	9	5	5	6	10	5.00
Sulfate	178	219	172	156	148	162	126	115
Sulfide	NR	NR	<1.5	NR	NR	NR	<1.5	NR
COD	<1	<20	22	3	16	33	60	11
NitrateNitrite - N	1.98	1.1	1.27	1.10	0.91	0.68	0.77	1.44
EPA METHOD 8260 (ug/L)								
(METHOD 8240 ON 4/93)								
Acetone		<50	<50 F	<50	<50	<50	<50(3.3JB)	<50
Benzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon Disulfide		3.9	1.2 F	2.9 F	14	<1.0	<1.0	<1.0
Chloroform		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane		0.66J F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorodifluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dichlorofluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloroethane		2.4 F	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.45J)
1,1-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
cis-1,2-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1(0.13J)	<1.0	<1.0
trans-1,2-Dichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ethyl Benzene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone		<20	<20	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tetrachloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1,1-Trichloroethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene		<1.0	0.22J F	<1.0	<1.0 (0.14J)	<1.0	<1.0	<1.0
Trichloroethene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichlorofluoromethane		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
m+p Xylenes		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
EPA METHOD 8151 (ug/L)								
2,4 - D		NR	NR	NR	NR	NR	<1.0	<1.0
Dacthal		NR	NR	NR	NR	NR	<1.0	<1.0
4-Nitrophenol		NR	NR	NR	NR	NR	<0.50	<0.50
Picloram		NR	NR	NR	NR	NR	<0.50	<0.50
2,4,5 - TP (Silvex)		NR	NR	NR	NR	NR	<0.20	<0.20
EPA METHOD 8270 (ug/L)								
1,4-Dichlorobenzene	NA	NA	NA	<10	<11	<10	<10	<10
Diethylphthalate	NA	NA	NA	<10	<11	<10	<10	<10
Di-n-Butylphthalate	NA	NA	NA	<10	<11	<10	<10	<10
bis(2-ethylhexyl) Phthalate	NA	NA	NA	<10	<11 (4.2J)	<10	<10	<10
2-Methylphenol	NA	NA	NA	<10	<11	<10	<10	<10
4Methylphenol/3Methylphenol	NA	NA	NA	<10	<11	<10	<10	<10
Phenol	NA	NA	NA	<10	<11	<10	<10	<10

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

BSB-A5 AND BSB-A6 GROUNDWATER MONITORING DATA

	BSB-A5			BSB-A6		
	8 / 95	12 / 95	2 / 96	11 / 95	12 / 95	2 / 96
DISSOLVED METALS (mg/L)						
Antimony	0.002	<0.003	0.003	0.005	0.003	<0.003
Arsenic	0.002	0.002	<0.001	0.008	0.012	0.01
Barium	0.028	0.022	0.026	0.035	0.059	0.052
Berrylium	0.0004	0.0002	<0.0001	<0.002	0.0006	<0.0001
Cadmium	<0.0001	<0.0001	<0.0001	0.0384	0.0164	0.021
Chromium	<0.010	<0.009	<0.008	0.015	0.03	0.027
Cobalt	<0.010	<0.010	<0.010	0.08	0.08	<0.010
Copper	<0.004	<0.002	<0.003	0.004	<0.002	<0.003
Iron	0.04	0.031	0.064	1.31	2.7	3.28
Lead	<0.001	0.002	<0.001	0.003	0.001	<0.001
Mercury	0.0002	<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Nickel	<0.01	<0.02	<0.01	0.16	0.02	0.02
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	<0.001	<0.001	<0.004	<0.001	0.001	0.021
Thallium	0.007	0.002	<0.001	<0.001	0.003	<0.001
Vanadium	<0.006	<0.004	<0.004	0.009	<0.004	<0.004
Zinc	0.027	<0.009	<0.009	17.5	10.7	9.77
INORGANICS (mg/L)						
Cyanide	<0.005	NR	NR	<0.005	NR	NR
Conductivity (umhos/cm)	704	NR	NR	2880	NR	NR
Chloride	20	NR	NR	60	NR	NR
Sulfate	278	NR	NR	1730	NR	NR
Sulfide	<1.5	NR	NR	NR	NR	NR
COD	534	NR	NR	431	NR	NR
Nitrate\Nitrite - N	0.05	NR	NR	0.08	NR	NR
EPA METHOD 8260 (ug/L) (METHOD 8240 ON 4/93)						
Acetone	<50(4.9JB)	<50	<50	<50	<50	<50
Benzene	<1.0	<1.0	<1.0	<1.0 (0.41J)	<1.0 (0.39J)	<1.0 (0.45J)
Carbon Disulfide	<1.0	<1.0	<1.0	<1.0	1.8	1.7
Chloroform	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0 (0.18J)
Chloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chloromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,4-Dichlorobenzene	<1.0	<1.0	<1.0	1.5	1.1	1.3
Dichlorodifluoromethane	<1.0	<1.0	<1.0 (0.14J)	5.2	10	7.1
Dichlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,1-Dichloroethane	<1.0	<1.0	<1.0 (0.14J)	5.8	5.5	5.7
1,2-Dichloroethane	<1.0	<1.0	<1.0 (0.31J)	<1.0 (0.62J)	<1.0 (0.58J)	<1.0 (0.85J)
1,1-Dichloroethene	<1.0	<1.0	<1.0	<1.0 (0.13J)	<1.0 (0.11J)	<1.0 (0.14J)
cis-1,2-Dichloroethene	<1.0 (0.63J)	1.6	1.5	66 D	49	88 D
trans-1,2-Dichloroethene	<1.0	<1.0	<1.0	<1.0 (0.57J)	<1.0 (0.46J)	<1.0 (0.56J)
1,2-Dichloropropane	<1.0	<1.0	<1.0	1.1	1.2	1.1
Ethyl Benzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methyl Ethyl Ketone	<20	<1.0	<20	<1.0	<1.0	<20
Methyl Isobutyl Ketone	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Methylene Chloride	<1.0	<1.0	<1.0	<1.0 (0.50JB)	<1.0	<1.0
Tetrachloroethene	<1.0 (0.41J)	2.6	2.7	2.7	3.0	2.9
1,1,1-Trichloroethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trichloroethene	<1.0	<1.0 (0.62J)	<1.0 (0.55J)	6.0	6.7	6.2
Trichlorofluoromethane	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vinyl Chloride	<1.0	<1.0	<1.0	1.0	<1.0 (0.92J)	<1.0 (0.90J)
m+p Xylenes	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
o-Xylene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
EPA METHOD 8151 (ug/L)						
2,4 - D	<1.0 (0.11J)	NR	NR	NR	NR	NR
Dacthal	<1.0	NR	NR	NR	NR	NR
4-Nitrophenol	<0.50	NR	NR	NR	NR	NR
Picloram	<0.50 (0.091J)	NR	NR	NR	NR	NR
2,4,5 - TP (Silvex)	<0.20	NR	NR	NR	NR	NR
EPA METHOD 8270 (ug/L)						
1,4-Dichlorobenzene	<11	NR	NR	NR	NR	NR
Diethylphthalate	<11	NR	NR	NR	NR	NR
Di-n-Butylphthalate	<11	NR	NR	NR	NR	NR
bis(2-ethylhexyl) Phthalate	<11 (2.8JB)	NR	NR	NR	NR	NR
2-Methylphenol	<11	NR	NR	NR	NR	NR
4Methylphenol/3Methylphenol	<11	NR	NR	NR	NR	NR
Phenol	<11	NR	NR	NR	NR	NR

NR = Not Requested
NA = Not Sampled
J = Estimated Quantity. Anlyte present, but less than the practical quantitation limit (PQL).
B = Analyte detected in associated reagent blank

D = Value derived from a 10X dilution
F = Analyte detected in associated field blank
D1 = Value derived from a 5.7X dilution
D2 = Value derived from a 50X dilution

CLK-1 GROUNDWATER MONITORING DATA

	7 / 23 / 96	7 / 30 / 96
DISSOLVED METALS (mg/L)		
Arsenic	0.021	0.027
Cadmium	0.0036	0.0034
Copper	0.009	0.010
Lead	<0.001	0.001
Zinc	101	106

DOWNGRADIENT WELLS DATA

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

Client: Pioneer Technical Services
Date Sampled: 10-APR-95 08:00
Date Received: 11-APR-95
Analysis Date: 12-APR-1995 23:34
File: /chem/5971A.i/va041295.b/apr122101021.d
Project Info: BSB Landfill
Sample Info: CR-1

Lab No.: 95-26190
Report Date: 04/14/95
Extraction Method: EPA 5030
Sample Matrix: WATER

Crematorium

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	**74-87-3**	**1.6**	
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	**107-06-2**	**<1.0**	**0.65J**
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

Crematorium

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.28	93	80--120
Toluene d8	10.0	10.2	102	80--120
p-Bromofluorobenzene	10.0	9.90	99	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

*= Compound was analyzed for on April 13,1995 on a second instrument.

REPORT COMMENTS: None

Analyst: (HH) Reviewing Supervisor: WBB

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P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

Client: Pioneer Technical Services
Date Sampled: 10-APR-95 08:45
Date Received: 11-APR-95
Analysis Date: 13-APR-1995 00:11
File: /chem/5971A.i/va041295.b/apr122201022.d
Project Info: BSB Landfill
Sample Info: CE-2

Lab No.: 95-26191
Report Date: 04/14/95
Extraction Method: EPA 5030
Sample Matrix: WATER

Cemetery - Near Office

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	**67-66-3**	**<1.0**	**0.33J**
Chloromethane	**74-87-3**	**2.6**	**
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	**107-06-2**	**<1.0**	**0.74J****
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	**127-18-4**	**<1.0**	**0.35J**
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

Cemetery - Nar Office

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.38	94	80--120
Toluene d8	10.0	10.2	102	80--120
p-Bromofluorobenzene	10.0	9.73	97	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

*= Compound was analyzed for on April 13,1995 on a second instrument.

**= The second analysis performed on this sample on April 13, 1995 yielded a value of 8.2 for chloromethane and 2.1 for 1,2-dichloroethane. The values for the other detected analytes agreed between the two runs. The second run was performed on the second vial of sample.

REPORT COMMENTS: None

Analyst: CHH Reviewing Supervisor: WTB

EPA METHOD 8260 BLANK SPIKE REPORT

Quality Control Sample: Certified Reference Sample Analysis 12-APR-95 21:09
Report Date: 04/13/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va041295.b/apr121701017.d
Remarks: This certified reference sample was spiked into a blank sample matrix then extracted and analyzed with your set of samples to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate results.

CONCENTRATION UNITS = ug/L (ppb)

Spike Compound	Added	Measured	%Rec	QC Limits
Carbon tetrachloride	5.00	4.93	99	60--140
Chlorobenzene	5.00	4.53	91	60--140
1,3-Dichlorobenzene	5.00	4.75	95	60--140
1,4-Dichlorobenzene	5.00	4.56	91	60--140
1,2-Dichloroethane	5.00	4.67	93	60--140
1,1-Dichloroethene	5.00	4.55	91	60--140
trans-1,2-Dichloroethene	5.00	4.47	89	60--140
1,2-Dichloropropane	5.00	4.50	90	60--140
Ethyl benzene	5.00	4.80	96	60--140
Tetrachloroethene	5.00	4.48	90	60--140
1,1,2-Trichloroethane	5.00	4.76	95	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.2	102	80--120
Toluene d8	10.0	8.68	87	80--120
p-Bromofluorobenzene	10.0	10.2	102	80--120

REPORT COMMENTS: None

Analyst: (illegible) Reviewing Supervisor: (illegible)

Quality Control Sample: Laboratory Reagent Blank 12-APR-95 21:45
Report Date: 04/13/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va041295.b/apr121801018.d
Remarks: This Laboratory Reagent Blank Quality Control Sample was extracted and analyzed with your set of samples to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.29	93	80--120
Toluene d8	10.0	9.63	96	80--120
p-Bromofluorobenzene	10.0	10.4	104	80--120

QUALIFIER CODES EXPLANATION:
U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: CHJ Reviewing Supervisor: WSM

Lab Nos. 95-26190-91

Date 04/11/95

Received by Pam Fink

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s) and associated sample custody information on receipt at the laboratory.

Chain-of-custody form completed & signed	Yes	Comments:_____
Chain-of-custody seal properly placed	Yes	Comments:_____
Chain of custody seal intact	Yes	Comments:_____
Signature Match, Chain-of-custody vs. Seal	Yes	Comments:_____
Sample received cold	Yes	Comments:_____
Samples received within holding time	Yes	Comments:_____
Samples received in proper containers and properly preserved	Yes	Comments:_____
Client notified about sample discrepancies	_____	Comments:_____

Who:_____By:_____Date/Time:_____

Method of Shipment: UPS

ENERGY LABORATORIES, INC.
P.O. Box 30916 1107 South Broadway
Billings, MT 59107
toll-free 800-735-4489
voice 406-252-6325
fax 406-252-6069

CHAIN OF CUSTODY RECORD

PLEASE PRINT OR TYPE ALL INFORMATION EXCEPT SIGNATURES

P.O. #

Project Name / Address: BSB Landfill

Contact Name & Phone: Shawn Bisch 782-5177

Sampler's signature:

Invoice to: Marc Murphy
P.O. Box 3445
Butte, MT 59702

Report to: Shawn Bisch
P.O. Box 3445
Butte, MT 59702

DATE	TIME	composite	grab sample	SAMPLE I.D.	number of containers	Sample Type: A W S V U O (Air Water Soils/solids Vegetation Urine Other)	Analysis Requested: VOCs 8260 Table I	Comments, Special Instructions, etc.
4/10/95	800		X	CR-1	2	W	X	Results promised for Friday 4/14 at no additional Cost.
4/10/95	845		X	CE-2	2	W	X	

1. Relinquished (signature)	Date	Time	Received by: (signature)	3. Relinquished (signature)	Date	Time	Received by (signature):
Shawn Bisch	4/10/95	1630					
2. Relinquished (signature)	Date	Time	Received by: (signature)	4. Relinquished (signature)	Date	Time	Received for laboratory by (signature):
					04/11/95	1319	Pam Fink

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FAX (406) 252-6069 • 1-800-735-4489

Client: Pioneer Technical Services
Date Sampled: 21-APR-95 10:00
Date Received: 24-APR-95
Analysis Date: 25-APR-1995 15:18
File: /chem/5971A.i/va042595.b/apr251101011.d
Project Info: Proj. Code 9503, BSB Landfill
Sample Info: BL-4

Lab No.: 95-27119
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER

BLANKENSHIP

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acetonitrile	75-05-8	<20	U
Acrolein	107-02-8	<20	U
Acrylonitrile	107-13-1	<20	U
Allyl chloride	107-05-1	<1.0	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U*
Isobutanol	78-83-1	<50	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	**74-87-3**	**3.0**	
Chloroprene	126-99-8	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,3-Dichlorobenzene	541-73-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	**107-06-2**	**1.2**	
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
1,3-Dichloropropane	142-28-9	<1.0	U
2,2-Dichloropropane	594-20-7	<1.0	U
1,1-Dichloropropene	563-58-6	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
Ethyl methacrylate	97-63-2	<1.0	U
Hexachlorobutadiene	87-68-3	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methacrylonitrile	126-98-7	<20	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methyl methacrylate	80-62-6	<1.0	U
Methylene chloride	75-09-2	<1.0	U
Naphthalene	91-20-3	<1.0	U
Pentachloroethane	76-01-7	<2.0	U
Propionitrile	107-12-0	<20	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,2,4-Trichlorobenzene	120-82-1	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.18	92	80--120
Toluene d8	10.0	9.66	97	80--120
p-Bromofluorobenzene	10.0	9.71	97	80--120

QUALIFIER CODES EXPLANATION:

U= Indicates compound was analyzed for but not detected.

*= Bromomethane was analyzed May 03, 1995.

REPORT COMMENTS:

Analyst: CHH WD Reviewing Supervisor: WTB

EPA METHOD 8260 BLANK SPIKE REPORT

Quality Control Sample: Certified Reference Sample Analysis 25-APR-95 10:13
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va042595.b/apr250301003.d
Remarks: This certified reference sample was spiked into a blank sample matrix then extracted and analyzed with your set of samples to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate results.

CONCENTRATION UNITS = ug/L (ppb)

Spike Compound	Added	Measured	%Rec	QC Limits
Carbon tetrachloride	5.00	5.28	106	60--140
Chlorobenzene	5.00	5.00	100	60--140
1,3-Dichlorobenzene	5.00	5.34	107	60--140
1,4-Dichlorobenzene	5.00	5.15	103	60--140
1,2-Dichloroethane	5.00	4.78	96	60--140
1,1-Dichloroethene	5.00	4.76	95	60--140
trans-1,2-Dichloroethene	5.00	4.98	100	60--140
1,2-Dichloropropane	5.00	4.57	91	60--140
Ethyl benzene	5.00	5.36	107	60--140
Tetrachloroethene	5.00	5.08	102	60--140
1,1,2-Trichloroethane	5.00	4.90	98	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.3	103	80--120
Toluene d8	10.0	9.96	100	80--120
p-Bromofluorobenzene	10.0	10.0	100	80--120

REPORT COMMENTS: None

Analyst: CHN Reviewing Supervisor: WTB

Quality Control Sample: Laboratory Reagent Blank 25-APR-95 14:40
Report Date: 04/25/95
Extraction Method: EPA 5030
Sample Matrix: WATER
File: /chem/5971A.i/va042595.b/apr251001010.d
Remarks: This Laboratory Reagent Blank Quality Control Sample was extracted and analyzed with your set of samples to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<50	U
Acetonitrile	75-05-8	<20	U
Acrolein	107-02-8	<20	U
Acrylonitrile	107-13-1	<20	U
Allyl chloride	107-05-1	<1.0	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Isobutanol	78-83-1	<50	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	<1.0	U
Chloroprene	126-99-8	<1.0	U
Dibromochloromethane	124-48-1	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,3-Dichlorobenzene	541-73-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
1,3-Dichloropropane	142-28-9	<1.0	U
2,2-Dichloropropane	594-20-7	<1.0	U
1,1-Dichloropropene	563-58-6	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethyl benzene	100-41-4	<1.0	U
Ethyl methacrylate	97-63-2	<1.0	U
Hexachlorobutadiene	87-68-3	<1.0	U

(report continued on page 2)

EPA METHOD 8260
VOLATILE ORGANICS ANALYSIS REPORT (continued)

CONCENTRATION UNITS = ug/L (ppb)

COMPOUNDS	CAS NO.	RESULT	QUALIFIER
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methacrylonitrile	126-98-7	<20	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methyl methacrylate	80-62-6	<1.0	U
Methylene chloride	75-09-2	<1.0	U
Naphthalene	91-20-3	<1.0	U
Pentachloroethane	76-01-7	<2.0	U
Propionitrile	107-12-0	<20	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,2,4-Trichlorobenzene	120-82-1	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added ug/L	Measured ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.0	100	80--120
Toluene d8	10.0	9.81	98	80--120
p-Bromofluorobenzene	10.0	10.3	103	80--120

QUALIFIER CODES EXPLANATION:
U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: CLH Reviewing Supervisor: WDB

Lab Nos. 95-27119

Date 04/24/95

Received by Randa Hoelscher

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s) and associated sample custody information on receipt at the laboratory.

Chain-of-custody form completed & signed	Yes	Comments:
Chain-of-custody seal properly placed	Yes	Comments:
Chain-of-custody seal intact	Yes	Comments:
Signature Match, Chain-of-custody vs. Seal	Yes	Comments:
Sample received cold	Yes	Comments:
Samples received within holding time	Yes	Comments:
Samples received in proper containers and properly preserved	Yes	Comments:
Client notified about sample discrepancies		Comments:

Who:_____ By:_____ Date/Time:_____

Method of Shipment UPS

CHAIN OF CUSTODY

PROJECT CODE	PROJECT NAME
9503	BSB Landfill

SAMPLERS (SIGNATURE) Shawn Birch 782-5177 Shawn Birch

SAMPLE INDENTIFICATION	SAMPLED DATE	SAMPLED TIME	ANALYSIS REQUESTED: VOC's 8260 (TCL+TE)	REMARKS
BL-4	4/21/95	1000	X	

RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)	RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)
Shawn Birch	4/21/95 1500				
RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)	RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED BY (SIGN.)
RELINQUISHED BY (SIGN.)	DATE TIME	RECIEVED FOR LAB (SIGN.)	DATE TIME		
		Landa Hoelscher	4/24/95 @ 1305		

REMARKS

PIONEER
TECHNICAL SERVICES, INC.
P.O. BOX 3445
BUTTE, MT 59701
PHONE: (406)-782-5177
FAX: (406)-782-5866

A Subsidiary of MTC

MSE, Inc. Corporate Office P.O. Box 4078 Butte, MT 59702 (406) 723-8213 FAX (406) 723-8328
Western Environmental Technology Office (WETO) Butte, MT 59702 (406) 494-7100 FAX (406) 494-7230

April 20, 1995

95MSE283

Shawn Bisch
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, MT 59701

Dear Shawn:

Please find enclosed analytical results for the water sample received at the MSE Laboratory April 10, 1995.

If you have any questions, please do not hesitate to call.

Sincerely,

Kevin Kissell
Laboratory Supervisor

KK/rbk

Enclosure

CLIENT: Pioneer Technical Services-BSB Landfill Report Date: 4/19/95 Page 1
FIELD ID: RE-3
LAB ID: W004019
DATE/TIME SAMPLED: 04/10/95 10:00:0
DATE RECEIVED: 4/10/95
F: 000468

REAP

METALS DISSOLVED

Antimony		0.009	mg/L
Arsenic		0.002	mg/L
Barium		0.017	mg/L
Beryllium		0.0003	mg/L
Cadmium		0.0002	mg/L
Chromium	<	0.009	mg/L
Cobalt	<	0.01	mg/L
Copper	<	0.002	mg/L
Iron		10.7	mg/L
Lead		0.003	mg/L
Mercury	<	0.0001	mg/L
Nickel	<	0.01	mg/L
Selenium	<	0.001	mg/L
Silver	<	0.001	mg/L
Thallium		0.003	mg/L
Vanadium		0.006	mg/L
Zinc		0.073	mg/L

CFW
Review

CLIENT: Pioneer Technical Services-BSB Landfill Report Date: 4/27/95 Page 1
FIELD ID: BL-4
LAB ID: W004097
DATE/TIME SAMPLED: 04/21/95 13:00:0
DATE RECEIVED: 4/21/95
F: 000495

Blom cen zinip

METALS DISSOLVED

Antimony	<	0.002	mg/L
Arsenic		0.002	mg/L
Barium		0.090	mg/L
Beryllium	<	0.0001	mg/L
Cadmium	<	0.0001	mg/L
Chromium	<	0.009	mg/L
Cobalt	<	0.01	mg/L
Copper		0.016	mg/L
Iron		0.088	mg/L
Lead	<	0.001	mg/L
Mercury	<	0.0001	mg/L
Nickel	<	0.01	mg/L
Selenium	<	0.001	mg/L
Silver	<	0.001	mg/L
Thallium	<	0.001	mg/L
Vanadium		0.006	mg/L
Zinc		0.539	mg/L

Review

MSE, INC.
CHAIN OF CUSTODY

Project Code	Project Name
9503	BSB Landfill

SAMPLERS (Signature) Allan Bish

SAMPLE IDENTIFICATION	SAMPLED DATE	SAMPLED TIME	Metals	Remarks
BL-4	4/21/95	1000	X	Rush

Relinquished by (Sign.)	Date	Time	Received by (Sign.)
Allan Bish	4/21/95	1250	
Relinquished by (Sign.)	Date	Time	Received by (Sign.)
Relinquished by (Sign.)	Date	Time	Recieved for Lab by (Sign.)	Date	Time
			Hans Christian	4-21-95	1250

Remarks

Rush

MSE, INC.
P.O. Box 4078
220 N. Alaska
Butte, MT 59702
PHONE: (800) 441-8213
FAX: (406) 723-8328

ACAD#: 1300-001
REV: B DATE: 6/9/93
DRAFTER: DB

APPENDIX B

MONTANA BUREAU OF MINES AND GEOLOGY
SURFACE WATER QUALITY DATA

MONTANA TECH
of The University of Montana

Montana Bureau of Mines and Geology
1300 West Park Street
Butte, Montana 59701-8997
(406) 496-4180

April 3, 1995

Mr. Brad Archibald
Pioneer Technical Services, Inc.
P.O. Box 3445
Butte, MT 59702

Dear Brad:

Enclosed are copies of water quality data from surface water samples collected by the Montana Bureau of Mines and Geology (MBMG). Sites sampled were Grove Creek, Silver Bow Creek, Blacktail Creek, and Missoula Gulch.

This data is from the Grove Creek report you called inquiring about. As I mentioned at that time, this report is still in Draft stage, however, in discussions with Jim Scott, MDHES, he has approved the release of the analytical data, which I believe was your main interest.

I hope you find the enclosed data helpful. Do not hesitate to call if you have further questions.

Sincerely,

Ted Duaime
Hydrogeologist

Enclosures
c: Jim Scott, MDHES

TD/bb

UP[illegible]CLARK PORK BASIN WATER QUALITY SAMPLING
(Silv[illegible]ow Cr., Blacktail Cr., Grove Creek, and Missoula Gulch)
4/2/1993

TABLE 1[illegible]

	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	PHYSICAL PARAMETERS FIELD SC (UMHOS)	pH	Eh (mv)	TEMP (C)	LAB SC (UMHOS)	PH	HARDNESS (MG/L)	ALKALINITY (MG/L)	PERCENT MEQ/L Ca	Mg	Na	HCO3	CO3	SO4
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																		
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	76.5	55.0	58.4	21.7	16.2	62.1	.0	30.8
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	96.7	83.4	56.2	23.8	16.9	66.7	.0	26.9
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	103.4	98.4	55.8	24.2	17.8	70.1	.0	24.2
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	126.8	109.9	57.2	23.2	17.6	71.6	.0	23.4
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																		
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	87.8	66.1	58.7	20.9	17.1	62.3	.0	30.0
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	106.2	96.5	56.5	23.6	17.1	68.6	.0	24.8
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	137.5	110.7	56.6	23.5	17.9	66.1	.0	26.7
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	136.7	113.2	57.8	22.5	17.0	67.0	.0	25.3
GROVE CREEK (ABOVE BSB LANDFILL)																		
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	130.1	78.2	55.9	21.0	19.6	51.1	.0	42.2
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	106.5	73.6	54.3	21.3	18.2	50.9	.0	42.5
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	181.1	132.1	60.1	21.5	15.9	61.8	.0	33.1
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	167.9	150.9	57.8	21.4	16.9	70.9	.0	25.3
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																		
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	167.4	115.2	56.7	21.1	18.8	54.3	.0	35.5
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	152.9	107.3	56.4	21.4	17.3	53.0	.0	37.4
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	213.3	162.3	57.3	22.7	16.9	61.2	.0	27.8
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	232.0	192.7	58.1	22.3	16.7	64.4	.0	23.3
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																		
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	181.3	124.5	55.2	20.4	20.6	52.9	.0	35.7
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	180.0	122.5	55.2	20.9	19.1	50.5	.0	37.0
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	326.1	276.6	50.8	20.8	24.3	58.5	.0	26.4
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	176.5	78.1	54.3	17.8	19.8	33.0	.0	48.8
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																		
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	99.0	71.9	58.2	21.9	16.8	62.5	.0	29.4
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	126.3	96.3	56.2	23.0	18.0	61.6	.0	30.5
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	141.5	121.3	56.6	23.2	17.9	66.8	.0	25.8
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	160.2	123.0	58.0	22.6	16.9	64.5	.0	27.7
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	152.4	117.0	55.2	21.6	19.1	60.5	.0	30.2
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																		
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	82.5	26.2	73.7	9.1	12.5	27.4	.0	62.1
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																		
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	165.0	107.0	57.1	21.3	17.8	53.2	.0	37.8
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	156.6	116.5	56.0	23.7	18.2	58.4	.0	34.3
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	161.8	93.5	60.8	21.6	15.0	49.1	.0	43.9
MISSOULA GULCH (@ CENTENNIAL AVE.)																		
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	230.4	92.4	64.7	19.4	13.7	33.8	.0	56.1
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	172.2	29.5	61.7	24.8	10.5	13.6	.0	80.8
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																		
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	182.4	111.8	54.1	18.5	21.5	41.6	.0	46.3
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	169.2	97.6	51.3	20.7	24.8	41.4	.0	45.4
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	183.4	117.3	50.9	21.0	24.8	47.0	.0	39.8

N/A - NOT ANALYIZED

					PHYSICAL PARAMETERS																		
					FIELD				LAB														
	DATE	TIME	FLOW	FLOW	SC	pH	Eh	TEMP	SC	PH	Ca	Mg	Na	K	Fe	Mn	SiO2	HCO3	CO3	Cl	SO4	NO3-N	F
	(MM/DD/YR)	(HRS)	(CFS)	(GPM)	(UMHOS)		(mv)	(C)	(UMHOS)		(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)	(MG/L)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																							
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	22.3	5.0	7.1	2.8	.58	.02	18.6	67.1	.0	4.5	26.2	.35	.32
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	27.2	7.0	9.4	2.9	.17	.06	25.2	101.7	.0	5.6	32.3	.79	.34
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	28.9	7.6	10.6	2.2	.08	.02	25.1	120.0	.0	5.4	32.9	.82	.41
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	36.1	8.9	12.7	2.4	.07	.02	28.3	134.0	.0	5.4	34.5	1.31	.61
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																							
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	25.9	5.6	8.7	2.9	.48	.03	20.0	80.6	.0	5.8	30.6	.79	.33
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	30.0	7.6	10.4	2.9	.15	.04	26.7	117.6	.0	6.6	33.4	1.26	.36
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	38.9	9.8	14.1	2.7	.06	.02	29.0	135.0	.0	8.5	42.9	1.83	.39
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	39.4	9.3	13.3	3.5	.06	.02	26.8	138.0	.0	9.2	41.0	1.98	.67
GROVE CREEK (ABOVE BSB LANDFILL)																							
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	37.9	8.6	15.3	4.7	.15	.06	23.9	95.4	.0	7.3	62.1	.15	.54
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	30.6	7.3	11.8	6.8	.25	.17	1.0	90.0	.0	6.7	59.2	.23	.50
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	53.4	11.6	16.2	4.3	.07	.09	36.0	161.0	.0	7.8	67.9	.07	1.22
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	49.1	11.0	16.5	6.4	.10	.04	36.0	184.0	.0	5.7	51.6	<0.1	.54
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																							
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	48.9	11.0	18.6	5.6	.60	.83	24.9	140.5	.0	15.4	72.3	.10	.78
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	44.4	10.2	15.6	7.5	.53	.76	25.6	130.8	.0	13.8	72.6	.36	.67
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	61.2	14.7	20.7	6.6	.18	1.54	28.2	197.9	.0	20.7	70.9	.05	1.00
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	67.2	15.6	22.1	6.6	2.55	3.93	34.8	235.0	.0	26.0	67.0	1.28	.69
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																							
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	53.0	11.9	22.6	7.1	.34	.31	1.0	151.8	.0	19.0	80.8	.23	.92
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	52.3	12.0	20.8	8.8	.51	1.86	25.0	149.3	.0	21.5	86.3	.36	1.00
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	92.7	23.0	51.0	14.7	.30	2.35	36.6	337.2	.0	50.4	120.0	<0.1	2.69
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	53.2	10.6	22.2	15.4	.23	2.42	22.6	95.2	.0	30.6	111.0	3.01	.66
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																							
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	28.8	6.6	9.5	3.0	.47	.05	20.1	87.6	.0	6.6	32.4	.90	.38
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	35.9	8.9	13.2	3.5	.15	.96	27.4	117.4	.0	8.8	45.7	1.28	.44
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	40.2	10.0	14.6	3.1	.13	.08	26.6	147.9	.0	9.5	45.0	<0.1	.52
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	46.2	10.9	15.4	4.0	.08	.09	31.7	150.0	.0	10.6	50.7	2.10	.59
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	43.9	10.4	17.4	6.4	.18	.19	26.5	142.6	.0	12.7	56.0	3.18	.77
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																							
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	29.4	2.2	5.7	3.7	.04	.61	6.7	32.0	.0	7.1	56.9	1.32	1.43
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																							
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	48.1	10.9	17.2	6.1	.16	.41	26.8	130.5	.0	12.8	72.9	2.58	.84
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	44.1	11.3	16.4	3.3	.07	.36	26.3	142.0	.0	10.3	65.7	1.45	.60
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	47.8	10.3	13.5	4.0	.09	.50	23.4	114.0	.0	9.5	80.3	1.73	.93
MISSOULA GULCH (@ CENTENNIAL AVE.)																							
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	71.0	12.9	17.3	4.8	.01	1.57	22.7	112.6	.0	19.5	147.0	3.56	1.26
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	49.2	12.0	9.6	4.7	.01	4.25	14.5	36.0	.0	8.7	169.0	1.29	1.11
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																							
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	54.4	11.3	24.8	11.5	.31	1.58	22.5	136.3	.0	23.0	119.5	5.82	.91
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	48.3	11.8	26.8	5.9	.16	1.25	26.3	119.0	.0	22.0	102.6	.96	.70
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	52.0	13.0	29.0	6.6	.13	.96	25.3	143.0	.0	23.3	95.3	3.80	.65

N/A - NOT ANALYZED

UP[illegible]CLARK FORK BASIN WATER QUALITY SAMPLING
(Silver Bow Cr., Blacktail Cr., Grove Creek, and Missoula Gulch)
4/ 2/1993

TABLE 1 ([illegible])

[illegible]3

					PHYSICAL PARAMETERS						DISSOLVED CONCENTRATION												
	DATE (MM/DD/YR)	TIME (HRS)	FLOW (CFS)	FLOW (GPM)	FIELD SC (UMHOS)	pH	Eh (mv)	TEMP (C)	LAB SC (UMHOS)	PH	Al (UG/L)	Ag (UG/L)	As (UG/L)	B (UG/L)	Ba (UG/L)	Be (UG/L)	Cd (UG/L)	Cr (UG/L)	Cu (UG/L)	Li (UG/L)	Pb (UG/L)	Sr (UG/L)	Zn (UG/L)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																							
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	348	<4	6.1	<40	31	N/A	<5	<5	20	4	<40	135	<6
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	<100	<6	3.0	<100	N/A	N/A	<1	<6	5	6	<1	168	8
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	<100	<10	5.2	<100	N/A	N/A	<6	<10	<10	<6	<100	187	<10
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	<50	<1	3.3	<100	56.9	<0.5	<2	<2	4	<6	<3	225	12
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																							
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	331	<4	5.5	70	32	N/A	<5	<5	19	4	<40	149	4
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	<100	<6	3.0	<100	N/A	N/A	<1	<6	5	<6	<1	185	9
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	<100	<10	4.9	<100	N/A	N/A	<6	<10	<10	8	<100	240	7
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	<100	<1	3.3	<100	54.1	<0.5	<2	<2	9	<6	<3	228	26
GROVE CREEK (ABOVE BSB LANDFILL)																							
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	<40	<4	5.3	130	35	N/A	5	<5	21	12	<40	228	176
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	<100	<6	8.0	131	N/A	N/A	<1	<6	11	<6	1	191	20
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	<100	<10	6.9	<100	N/A	N/A	<6	<10	12	20	<100	311	<10
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	<100	<1	6.4	<100	50.3	<0.5	<2	<2	18	<6	<3	272	20
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																							
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	258	<4	7.2	125	38	N/A	<5	<5	19	9	<40	280	53
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	<100	<6	7.0	<100	N/A	N/A	<1	<6	5	6	<1	249	30
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	<100	<10	10.0	<100	N/A	N/A	<6	<10	<10	7	<100	350	20
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	<100	<1	14.7	<100	67.9	<0.5	<2	<2	2	<6	<1	376	36
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																							
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	249	8	12.0	40	34	N/A	<5	<5	44	10	<40	302	37
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	<100	<6	10.0	<100	N/A	N/A	<1	<6	24	7	<1	310	117
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	<100	12	17.6	228	N/A	N/A	<6	<10	<10	<6	<100	590	19
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	<100	<1	19.6	210	48.6	<0.5	<2	<2	50	7	3	252	759
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																							
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	127	<4	6.4	<40	37	N/A	<5	<5	9	5	<40	164	<6
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	<100	<6	6.0	<100	N/A	N/A	<1	<6	4	7	<1	215	15
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	<100	<10	8.5	<100	N/A	N/A	<6	<10	<10	<6	<100	243	<10
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	<100	<10	5.3	<100	58.7	<0.5	<2	<6	5	<6	<1	267	40
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	<50	<6	17.2	<100	N/A	N/A	<6	<6	33	<6	<50	265	92
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																							
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	<50	<6	10.2	<100	N/A	N/A	<6	<6	605	<6	<50	59	1050
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																							
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	<50	<6	15.5	<100	N/A	N/A	<6	<6	105	6	<50	287	556
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	<100	10	7.5	<100	N/A	N/A	<6	<10	<10	<6	<100	274	318
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	70	<1	4.3	220	49.7	<0.5	5	<1	311	<6	2	247	1261
MISSOULA GULCH (@ CENTENNIAL AVE.)																							
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	<50	<6	4.5	150	N/A	N/A	9	<6	50	10	<50	368	2280
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	42	<1	<1	204	41.7	<0.5	30	<2	526	7	<3	249	8520
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																							
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	<50	<6	23.0	120	N/A	N/A	<6	<6	322	8	<50	304	2090
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	<100	<10	12.7	130	N/A	N/A	<6	<10	192	11	<100	300	1620
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	<100	<10	11.3	180	34.7	4	2	<6	94	<6	1	316	942

N/A - NOT ANALYIZED

					PHYSICAL PARAMETERS						DISSOLVED METAL LOADING RATE, POUNDS PER DAY						
					FIELD				LAB								
	DATE	TIME	FLOW	FLOW	SC	pH	Eh	TEMP	SC	PH	Fe	Mn	SO4	Al	As	Cu	Zn
	(MM/DD/YR)	(HRS)	(CFS)	(GPM)	(UMHOS)		(mv)	(C)	(UMHOS)		(lb/d)	(lb/d)	(lb/d)	(lb/d)	(lb/d)	(lb/d)	(lb/d)
BLACKTAIL CREEK AT FATHER SHEEHAN PARK																	
GC-6	5/15/1991	18:10	15.8	7110	180	7.7	257.3	12.8	196	7.5	49.56	2.04	2231.24	29.64	.52	1.70	.00
	3/ 6/1992	14:25	7.1	3195	234	7.4	236.0	9.1	255	7.9	6.62	2.10	1236.09	.00	.11	.19	.31
	6/19/1992	14:00	3.5	1589	310	7.7	257.0	22.7	280	8.0	1.60	.38	625.98	.00	.10	.00	.00
	8/20/1992	14:10	2.3	1030	305	7.5	-46.8	15.8	313	7.9	.88	.30	425.63	.00	.04	.05	.15
BLACKTAIL CREEK ABOVE CONFLUENCE WITH GROVE CREEK																	
GC-5	5/15/1991	17:00	20.2	9090	280	7.6	288.1	15.5	233	7.5	52.26	3.05	3331.67	36.04	.60	2.07	.44
	3/ 6/1992	15:00	9.3	4185	248	7.7	262.2	10.5	278	7.9	7.62	1.90	1674.24	.00	.15	.25	.45
	6/19/1992	14:50	7.8	3510	425	7.7	246.0	25.3	340	7.8	2.44	1.01	1803.60	.00	.21	.00	.29
	8/20/1992	17:00	6.3	2841	327	7.1	-31.3	18.5	354	7.7	1.87	.78	1395.18	.00	.11	.30	.87
GROVE CREEK (ABOVE BSB LANDFILL)																	
GC-1	5/15/1991	11:10	.7	315	295	8.1	96.5	9.5	340	7.8	.55	.23	234.30	.00	.02	.08	.66
	3/ 6/1992	10:41	.4	180	276	8.2	27.4	3.3	297	7.6	.54	.37	127.64	.00	.02	.02	.04
	6/19/1992	11:12	.2	68	360	7.6	249.3	17.0	420	7.9	.06	.07	54.90	.00	.01	.01	.00
	8/20/1992	12:40	.0	2	372	7.7	-66.5	19.0	424	8.2	.00	.00	1.17	.00	.00	.00	.00
GROVE CREEK (BELOW BSB LANDFILL, @ MT ST)																	
GC-2	5/15/1991	12:30	1.1	495	440	7.6	138.8	11.7	430	7.4	3.56	4.92	428.67	1.53	.04	.11	.31
	3/ 6/1992		.4	180	385	8.1	N/A	6.5	408	7.6	1.15	1.63	156.53	.00	.02	.01	.06
	6/19/1992	11:23	.3	135	469	7.3	229.1	16.9	510	7.5	.29	2.49	114.65	.00	.02	.00	.03
	8/20/1992	13:00	.0	22	540	7.2	-26.9	12.1	580	7.6	.68	1.05	17.82	.00	.00	.00	.01
GROVE CREEK ABOVE CONFLUENCE WITH BLACKTAIL CREEK																	
GC-3	5/15/1991	13:50	.2	90	460	7.7	243.8	17.4	470	7.9	.36	.34	87.10	.27	.01	.05	.04
	3/ 6/1992	13:05	.1	45	476	7.8	129.8	6.5	490	7.5	.27	1.00	46.52	.00	.01	.01	.06
	6/19/1992	16:00	N/A	N/A	770	7.1	113.0	25.3	880	7.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	8/20/1992	13:30	.0	3	490	7.0	-18.8	15.0	510	7.0	.01	.08	3.86	.00	.00	.00	.03
BLACKTAIL CREEK ABOVE CONFLUENCE WITH SBC (USGS GAGE)																	
GC-4	5/15/1991	15:06	19.1	8595	240	7.9	305.8	13.0	248	7.6	47.97	5.56	3335.55	13.07	.66	.93	.00
SS-04	3/ 6/1992	15:30	11.0	4950	305	7.8	244.7	9.1	327	7.8	8.77	56.92	2709.55	.00	.36	.24	.89
	6/19/1992	13:40	19.4	8730	412	7.7	244.0	23.5	359	8.1	13.07	8.26	4705.47	.00	.89	.00	.00
	8/21/1992	09:30	13.0	5850	346	7.4	-36.5	12.4	386	7.5	5.26	6.52	3552.55	.00	.37	.37	2.81
	6/12/1992	07:00	10.0	4500	360	7.4	N/A	18.9	412	7.4	9.81	10.03	3018.40	.00	.93	1.78	4.96
SILVER BOW CREEK AT TEXAS AVE. (METRO STORM DRAIN)																	
SS-02	6/11/1992	16:30	.0	0	180	6.8	N/A	19.1	212	6.7	.00	.00	.00	.00	.00	.00	.00
SILVER BOW CREEK BELOW CONFLUENCE WITH BLACKTAIL CR. (@ MT ST)																	
TM-01	6/12/1992	07:30	N/A	N/A	440	7.1	N/A	19.5	724	7.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6/19/1992	09:43	10.4	4680	387	7.6	239.7	13.3	404	7.8	3.64	20.01	3682.88	.00	.42	.00	17.83
	8/20/1992	11:50	15.4	6930	377	6.7	-14.2	13.4	394	7.4	7.06	41.09	6665.38	5.81	.36	25.81	104.67
MISSOULA GULCH (@ CENTENNIAL AVE.)																	
TM-02	6/11/1992	17:45	N/A	N/A	510	7.4	N/A	18.0	561	7.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	6/20/1992	11:00	.6	251	424	6.1	13.1	14.1	458	7.1	.02	12.78	508.09	.13	.00	1.58	25.61
SILVER BOW CREEK BELOW COLORADO TAILINGS (@ USGS GAGE)																	
SS-07	6/12/1992	08:00	19.0	8550	480	7.2	N/A	17.9	548	7.2	31.75	161.81	12238.00	.00	2.36	32.98	214.04
	6/19/1992	12:55	20.0	9000	605	7.1	309.7	19.5	530	7.4	17.36	134.75	11060.28	.00	1.37	20.70	174.64
	8/21/1992	09:45	17.0	7650	400	7.1	-21.5	15.9	540	7.4	12.00	87.69	8732.34	.00	1.04	8.61	86.32

N/A - NOT ANALYIZED

APPENDIX C

LANDFILL/SOIL GAS INVESTIGATION DATA

GEOPROBE DATA REPORT

FOR:

OLD BUTTE SILVER BOW LANDFILL
LOCATED IN BUTTE, MONTANA

Prepared for:

Pioneer Technical Services
P.O. Box 3445
Butte, Montana 59702

Prepared by:

Atlatl, Inc.
121002 Browns Gulch Road
Butte, MT 59701

Atlatl Project #:
PIONEERM03

February 22, 1996

INTRODUCTION

On February 7, 1996, Atlatl mobilized it's Geoprobe unit to the Old Butte Silver Bow landfill site, to collect and analyze soil-gas and groundwater samples, and to collect soil-gas, groundwater, and soil samples for laboratory analysis, as part of an initial investigation being conducted by Pioneer Technical Services. The soil-gas and groundwater samples were field screened to determine the presence of 1,1,1-Trichloroethane, 1,1-Dichloroethane, Tetrachloroethene, Trichloroethylene, and Cis-1,2,- Dichloroethylene in the subsurface, within and surrounding the Old Butte Silver Bow County landfill, located southwest of Butte, Montana. Past monitoring of the old landfill site indicated that the above compounds were present in the groundwater. Therefore, those compounds were used as indicators of contamination. The results of the soil gas analyses are intended to be used as qualitative data only, expressing locations of relative (low to high) concentrations of targeted compounds. Other compounds were also detected in addition to the above target compounds. These additional compounds were not identified but are present on the chromatograms. The unidentified compounds were not utilized for total concentration calculations.

The soil-gas survey, groundwater and soil sample collection were conducted utilizing Atlatl's Geoprobe unit, a fully mobile four wheel drive van. The Geoprobe is equipped with a hydraulically operated Model 8-ML probe/drive hammer unit and a full range of environmental sampling equipment. In addition, the Geoprobe is equipped with an on-board, laboratory grade, gas chromatograph (GC) capable of detecting a wide range of volatile compounds.

SOIL GAS SAMPLING

Soil-gas samples were collected using the Geoprobe Post-Run Tubing System (PRT). The PRT attaches to the sample point holder with a stainless steel connection sealed with an O-ring. The PRT system was inserted into the hollow 1.125 inch outside diameter, three foot steel probe rods. The steel probe rods were driven to the desired depths with the hydraulic hammer unit and then retracted approximately one inch. Retracting the probe rods in this manner separates the drive point from the rods, thus allowing an opening for soil-gas to enter the PRT. Soil-gas was collected through the PRT system utilizing the on-board vacuum pump. The PRT was purged with a volume of approximately one liter of soil-gas, prior to sampling. The soil-gas sample was collected from the PRT utilizing a 1000 μl syringe inserted through a silicon septum in the PRT extraction tube. All soil-gas samples were then injected into the on-board GC for analysis.

Analysis

The soil-gas samples were analyzed using the on-board Shimadzu GC-14A gas chromatograph. Sample analyses were performed utilizing both a Photoionization Detector (PID) and a Flame Ionization Detector (FID). The PID was selected for those compounds which have ionization potentials less than 10.2 electron volts (ev) and the FID was used to detect those compounds that have ionization potentials greater than 10.2 ev.

Twelve soil gas samples were collected and analyzed throughout the site and surrounding areas.

Results of the analyses are summarized and presented in Table 1. The chromatogram reports are included in Attachment A. The chromatogram reports list the soil-gas concentrations in micrograms per liter (μg/l).

Quality Assurance/Quality Control

Prior to in-field analysis, the GC was calibrated and the optimum carrier gas flow rates and system temperatures were identified. The PID and FID were calibrated with a commercially prepared standard for 1,1,1-Trichloroethane, 1,1-Dichloroethane, Tetrachloroethene, Trichloroethylene, and Cis-1,2,- Dichloroethylene. Three concentrations of the standard were vaporized and injected into the GC to calibrate the detector measurements and to determine standard column retention times. The response factors associated with the standard injections were averaged. A retention time window of 10% was established for peak recognition during sample analysis. The GC reporting limit of the above compounds was established at 2.5 μg/l.

One blank (ambient air) and one baseline sample were analyzed for Quality Assurance/Quality Control (QA/QC) purposes and to establish baseline levels of interference. The QA/QC blank and baseline sample analyses results were below the reporting limit of 2.5 μg/l for the target compounds. It should be noted that an impact was observed, on the FID, from the methane-ranged organics collected with the soil-gas sample.

The methane-ranged organics affected the GC results from the FID, requiring manual changes to the baseline of the chromatograms. The methane-ranged organics had a retention times beginning at .5 minutes, and sometimes affected results up to 1.5 minutes or greater, depending on concentrations. Therefore, peak areas between .5 and 1.5 were ignored during interpretation.

GROUNDWATER SAMPLING

Groundwater samples were collected utilizing the Geoprobe mill slot system and the tubing and check ball system. Groundwater was obtained from a depth at approximately fifty feet below the ground surface. Groundwater was very difficult to collect due to the characteristics of the soils and the lack of water present in the soils. Atlatl collected, when possible, one 20 ml sample for field screening and two 40 ml vials and a one liter sample for analysis in the laboratory.

A heated-headspace method was used in the field to screen the groundwater. The 20-ml sample of groundwater to be analyzed was placed in a 40-ml vial with a septum cap. The samples were then placed in a aluminum block heater and allowed to equilibrate for 15 minutes at 90 degrees C. Vapor from the headspace was removed and injected (by syringe) into the GC for analysis.

Table 1: Soil-Gas Sample Results
Old Butte Silver Bow County Landfill, Butte, MT

Location	Date	Depth	GC Ref. #	1,1-Dichloro-ethane µg/l	Cis 1,2 Dichloro-ethene µg/l	1,1,1-Trichloro-ethane µg/l	Trichloro-ethylene µg/l	Tetra-chloro-ethene µg/l
SG #1	2/7/96	20.0	DATA001F DATA002F	<2.5	<2.5	<2.5	<2.5	<2.5
SG #1	2/7/96	38.0	DATA003F DATA004F	<2.5J	<2.5	<2.5	<2.5	<2.5
SG #4	2/7/96	3.5	DATA007F DATA008F	<2.5J	<2.5	<2.5	<2.5	<2.5
SG #4	2/7/96	10.0	DATA009F DATA010F	<2.5J	<2.5	<2.5	<2.5	<2.5
SG #5	2/7/96	3.0	DATA012F	<2.5J	<2.5	<2.5	<2.5	<2.5
SG #6	2/7/96	8.5	DATA013F DATA014F	24.1	4.1	55.6	<2.5J	<2.5
SG #7	2/7/96	5.0	DATA015F DATA016F	11.7	2.9	21.4	<2.5J	<2.5
SG #8	2/7/96	5.0	DATA017F DATA018F	9.2	<2.5J	7.3	<2.5J	<2.5J
SG #9	2/8/96	4.0	DATA001G DATA002G	12.7	<2.5J	<2.5	<2.5	<2.5
SG #10	2/8/96	4.5	DATA003G DATA004G	<2.5J	<2.5	<2.5	<2.5	<2.5J
SG #10	2/8/96	12.0	DATA005G DATA006G	3.5	<2.5	<2.5	<2.5J	5.6
SG #14	2/8/96	4.5	DATA016G	<2.5J	<2.5	<2.5	<2.5	<2.5

J - Component present but under reporting limit

Analysis

The groundwater samples were analyzed using the on-board Shimadzu GC-14A GC. Sample analyses were performed utilizing a Photoionization Detector (PID) and a Flame Ionization Detector (FID).

Atlatl collected and analyzed five groundwater samples throughout the site and surrounding areas. Results of the analyses are summarized in Table 2. The chromatogram reports are included in Attachment B. The chromatogram reports list the groundwater concentrations in μg/l.

Quality Assurance/Quality Control

Prior to in-field analysis, the GC was calibrated and the optimum carrier gas flow rates and system temperatures were identified. The PID and FID were calibrated with a commercially prepared standard for 1,1,1-Trichloroethane, 1,1-Dichloroethane, Tetrachloroethene, Trichloroethylene, and Cis-1,2,- Dichloroethylene. Three levels of field standards were prepared. The appropriate amount of the commercial standard, for each level of field standard, was injected into a 40-ml vial containing 20 ml of distilled water. Each of the three vials was labeled with the correct concentration and stored on ice until it could be processed through the GC. Each field standard was then placed in an aluminum block heater and allowed to equilibrate for 15 minutes at 90 degrees C. Vapor from the headspace was removed and injected (by syringe) into the GC to calibrate the detector measurements and to determine standard column retention times. The response factors associated with the standard injections were averaged. A retention time window of 10% was established for peak recognition during sample analysis. The GC reporting limit of the above compounds was established at 0.5 μg/l.

One blank (distilled water) and one baseline sample were analyzed for Quality Assurance/Quality Control (QA/QC) purposes and to establish baseline levels of interference. The QA/QC blank and baseline sample analyses results were below the reporting limit of 0.5 μg/l for the target compounds.

Table 2: Groundwater Sample Results
Old Butte Silver Bow County Landfill, Butte, MT

Location	Date	Depth	GC Ref. #	1,1-Dichloro-ethane µg/l	Cis 1,2 Dichloro-ethene µg/l	1,1,1-Trichloro-ethane µg/l	Trichloro-ethylene µg/l	Tetra-chloro-ethene µg/l
SG #1	2/7/96	49.0	DATA005F DATA006F	<0.5	1.7	<0.5	<0.5J	<0.5
SG #11	2/8/96	52.0	DATA007G DATA008G	4.6	5.9	<0.5	1.0	<0.5J
SG #12	2/8/96	50.0	DATA009G DATA010G	.6	<0.5J	<0.5	<0.5	<0.5
WELL A3	2/8/96		DATA013G DATA014G	<0.5	41	<0.5	.9	<0.5
WELL A2	2/8/96		DATA017G DATA018G	42	157	<0.5	13	7.2

J- Component present but below reporting limit

ATTACHMENT A

*** Concentration Report for << DATA001F >>, Printed: 02/07/96 8:59a ***

Raw data file created: 02/07/96 8:57a
tection results file created: 02/07/96 8:59a
Final results file created: 02/07/96 8:59a

Name: pioneer3
mment:

strumentation comment:

: 0 Channel: A
quisition method: BSBSG

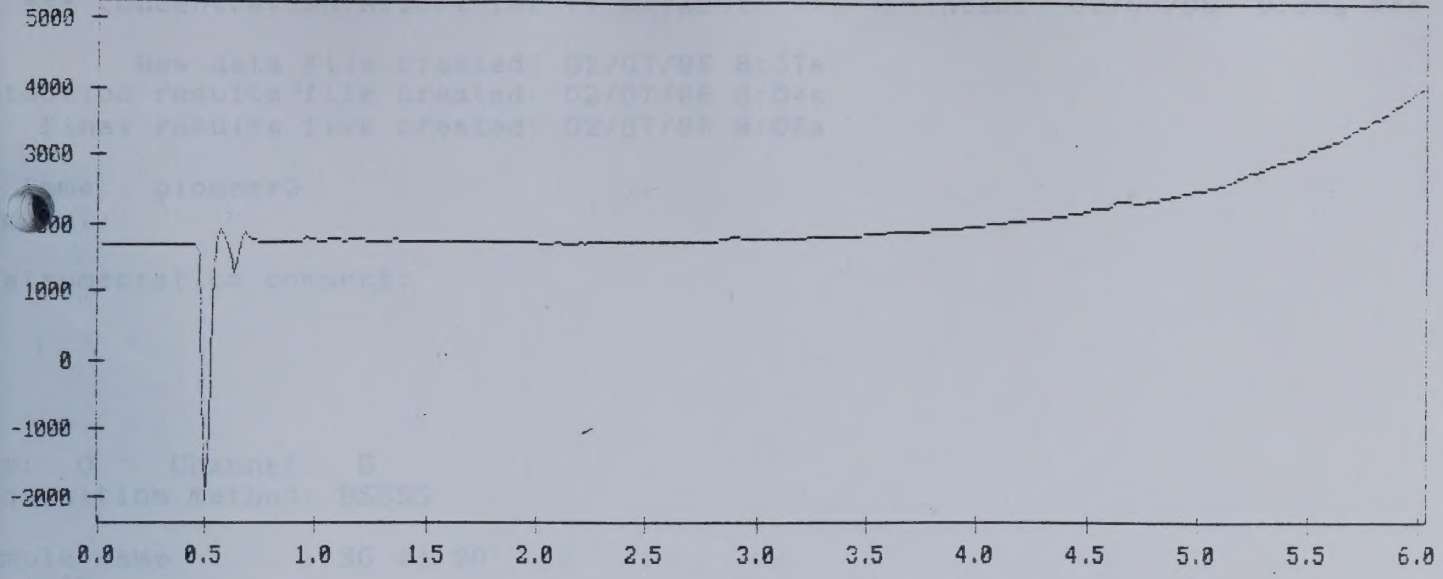
nple name : SG #1 20'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
nple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
libration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section : created 02/05/96 11:22p, modified 02/06/96 4:27p

nber of raw data points : 361
ıber of peaks detected : 0
ıber of components entered : 3
nber of components found : 0
ıber of components not found: 3
ıber of unidentified peaks : 0

nerior peak labels: Retention Time



FULL REPORT

Raw data file : DATA001F 9:00a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA002F >>, Printed: 02/07/96 9:06a ***

Raw data file created: 02/07/96 8:57a
tection results file created: 02/07/96 9:04a
Final results file created: 02/07/96 9:05a

Name: pioneer3
nt:

strumentation comment:

x: 0 Channel: B
quisition method: BSBSG

mple name : SG #1 20'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: FIDSG
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libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ting section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

nber of raw data points : 360
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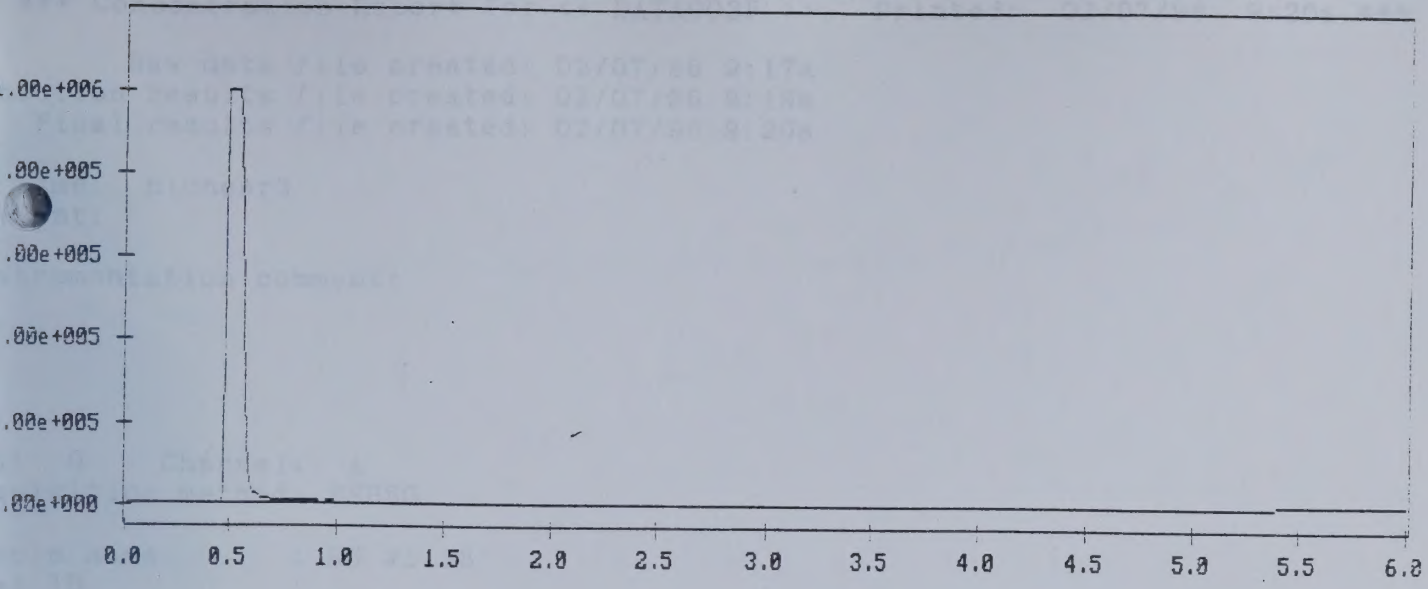
nber of components entered : 5
nber of components found : 0
nber of components not found: 5
nber of unidentified peaks : 0

perior peak labels: Retention Time



FULL REPORT

Raw data file : DATA002F 9:07a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	NF	Not Found	Not Found	1157.3291	Not Found	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA003F >>, Printed: 02/07/96 9:20a ***

Raw data file created: 02/07/96 9:17a
tection results file created: 02/07/96 9:19a
Final results file created: 02/07/96 9:20a

Name: pioneer3
nt:

strumentation comment:

x: 0 Channel: A
quisition method: BSBSG

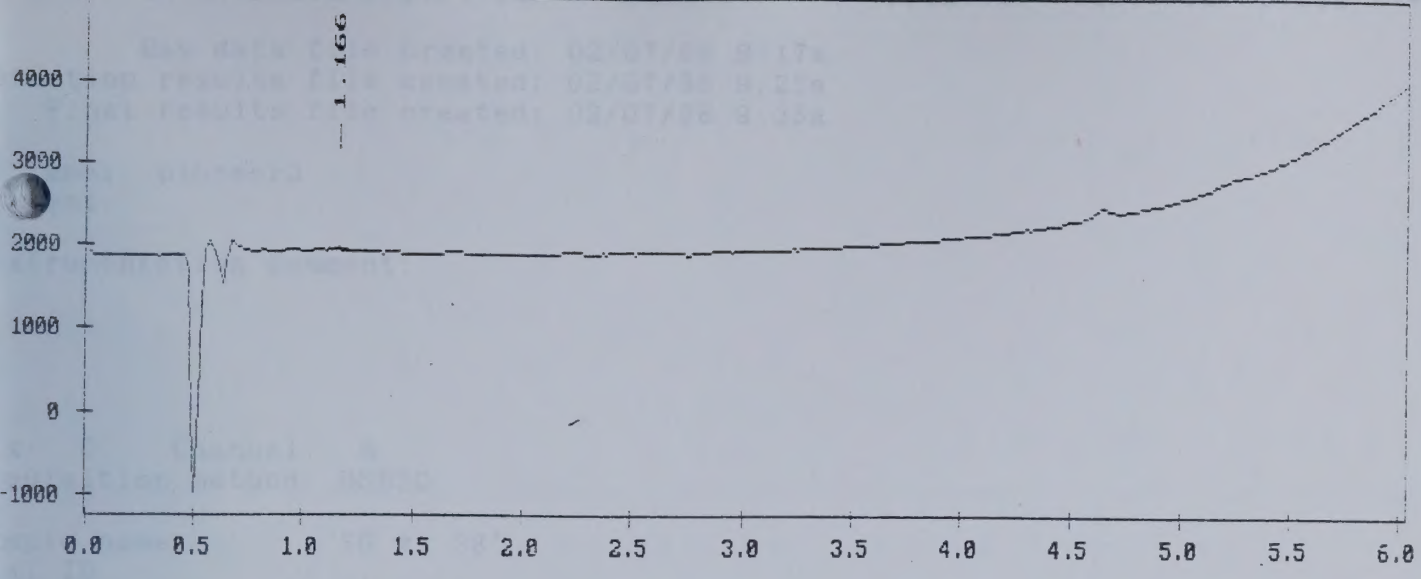
mple name : SG #1 38'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
libration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
romatogram baseline is manually edited

mber of raw data points : 361
mber of peaks detected : 1
mber of components entered : 3
mber of components found : 0
mber of components not found: 3
mber of unidentified peaks : 1

perior peak labels: Retention Time



FULL REPORT

Raw data file : DATA003F 9:21a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA004F >>, Printed: 02/07/96 9:36a ***

Raw data file created: 02/07/96 9:17a
etection results file created: 02/07/96 9:23a
Final results file created: 02/07/96 9:35a

Name: pioneer3
ent:

strumentation comment:

x: 0 Channel: B
quisition method: BSBSG

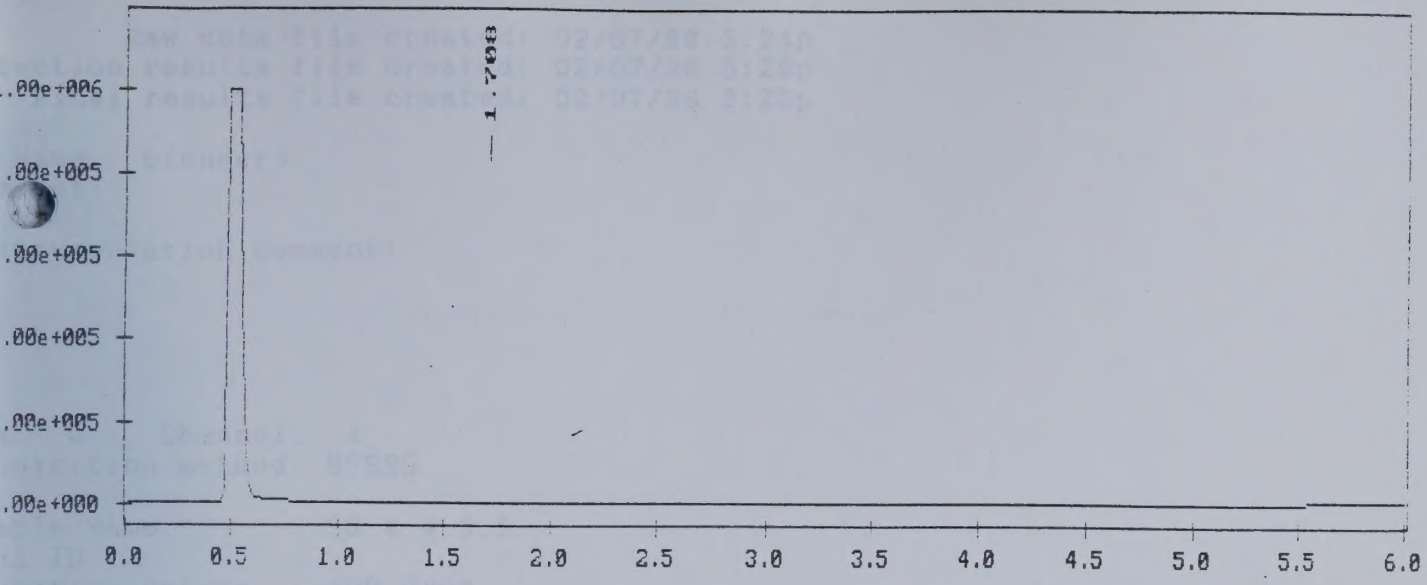
mple name : SG #1 38'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
rting section : created 02/05/96 11:51p, modified 02/06/96 4:26p
matogram baseline is manually edited

nber of raw data points : 360
nber of peaks detected : 1
mber of components entered : 5
nber of components found : 1
nber of components not found: 4
mber of unidentified peaks : 0

perior peak labels: Retention Time



FULL REPORT

Raw data file : DATA004F 9:36a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.708	1845.00170	581.054993	1157.3291	1.594189	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.818
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		1845.00170	581.054993		1.594189	

```
      Raw data file created: 02/07/96 3:24p
tection results file created: 02/07/96 3:26p
  Final results file created: 02/07/96 3:26p

 Name:  pioneer3
nment:

strumentation comment:



x:  0    Channel:  A
quisition method: BSBSG

mple name        : SG # 4 3.5
al ID            :
jection volume   : 500.0000
 amount (Sample): 0.000000
ple amount       : 1.000000
.ution factor    : 1.000000

 amount (Calib)      : 0.000000
. amount multiplier: 1.000000
. response factor   : 1.000000

cessing method: PIDSG
egration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
libration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section  : created 02/05/96 11:22p, modified 02/06/96 4:27p

mber of raw data points     : 361
mber of peaks detected      : 1
ber of components entered   : 3
nber of components found    : 0
mber of components not found: 3
 ber of unidentified peaks  : 1

perior peak labels: Retention Time
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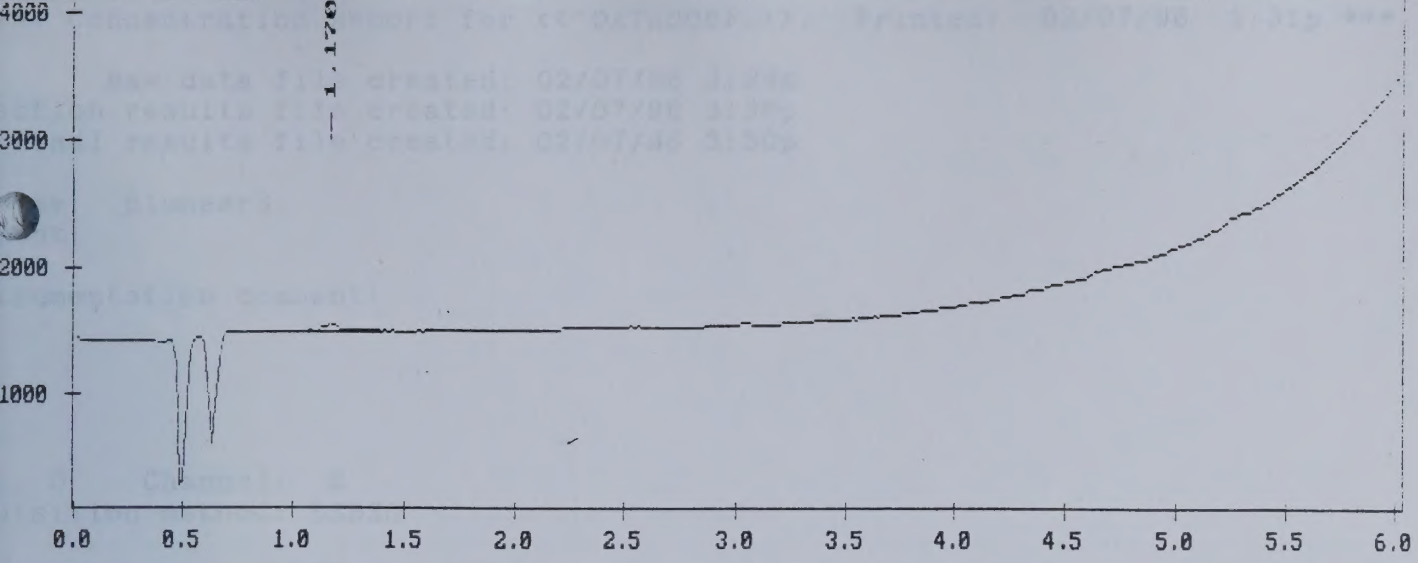
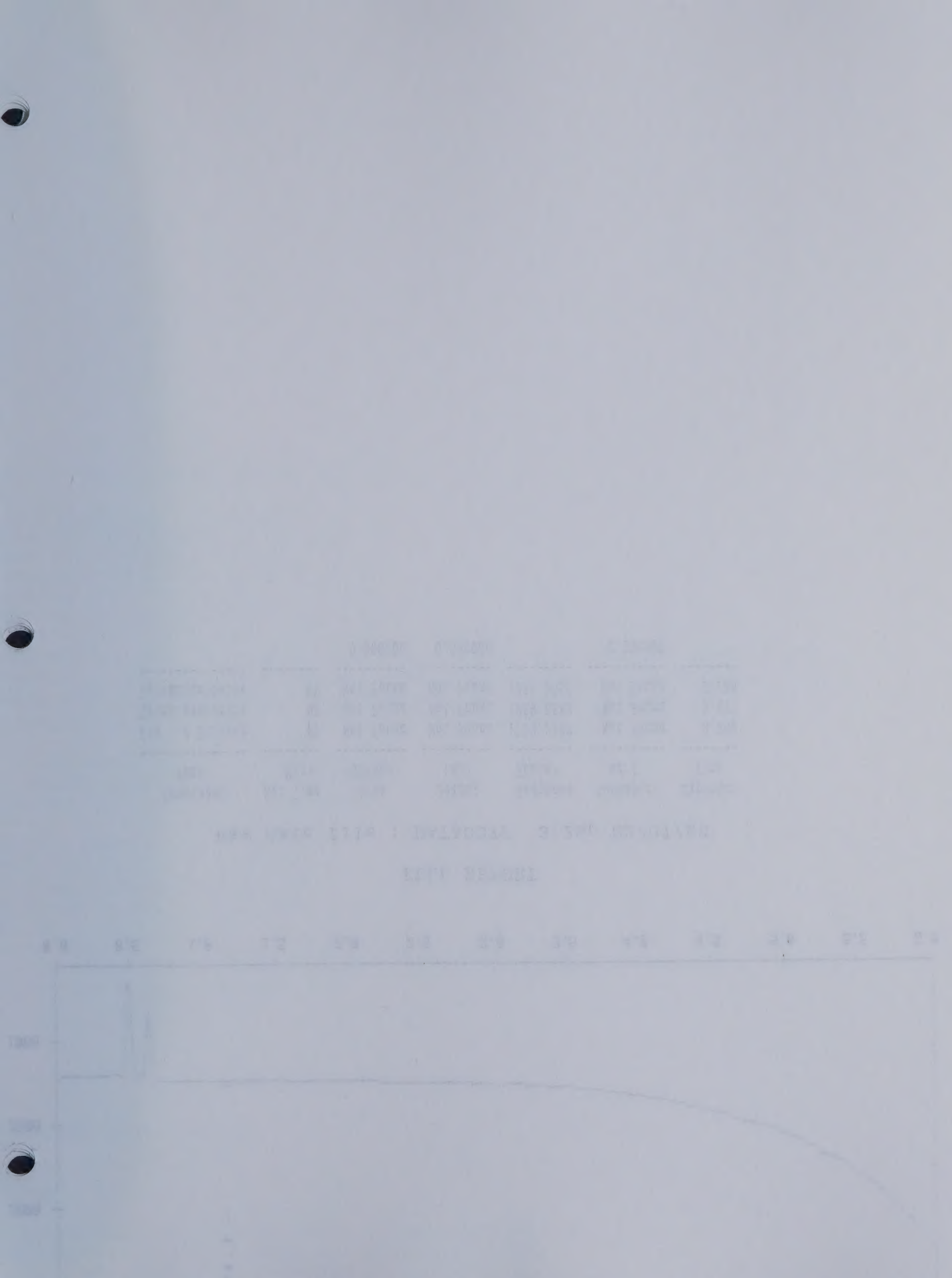


FULL REPORT

Raw data file : DATA007F 3:29p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		0.000000	0.000000		0.000000	



*** Concentration Report for << DATA008F >>, Printed: 02/07/96 3:31p ***

Raw data file created: 02/07/96 3:24p
tection results file created: 02/07/96 3:30p
Final results file created: 02/07/96 3:30p

me: pioneer3
mment:

strumentation comment:

: 0 Channel: B
quisition method: BSBSG

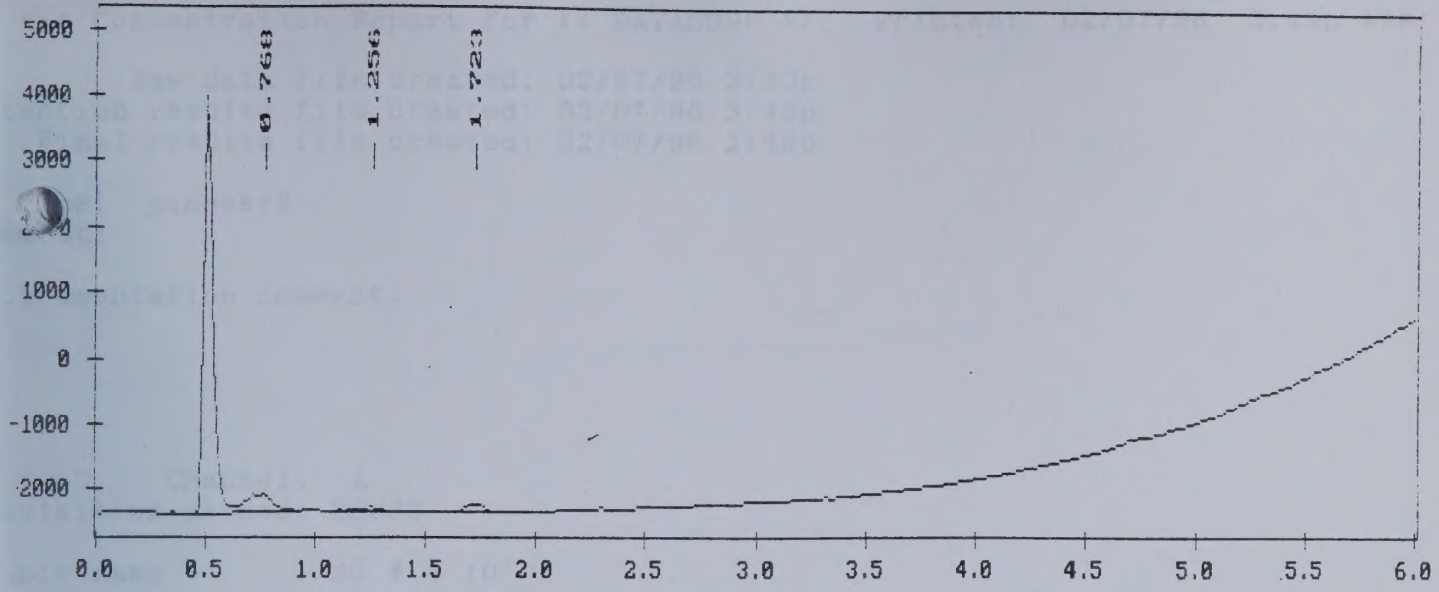
mple name : SG # 4 3.5
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ting section : created 02/05/96 11:51p, modified 02/06/96 4:26p

mber of raw data points : 360
ber of peaks detected : 3
mber of components entered : 5
mber of components found : 1
ber of components not found: 4
mber of unidentified peaks : 2

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA008F 3:32p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.723	699.968201	135.019226	1157.3291	0.604813	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		699.968201	135.019226		0.604813	

*** Concentration Report for << DATA009F >>, Printed: 02/07/96 3:49p ***

Raw data file created: 02/07/96 3:40p
ection results file created: 02/07/96 3:45p
Final results file created: 02/07/96 3:48p

e: pioneer3
ment:

trumentation comment:

: 0 Channel: A
uisition method: BSBSG

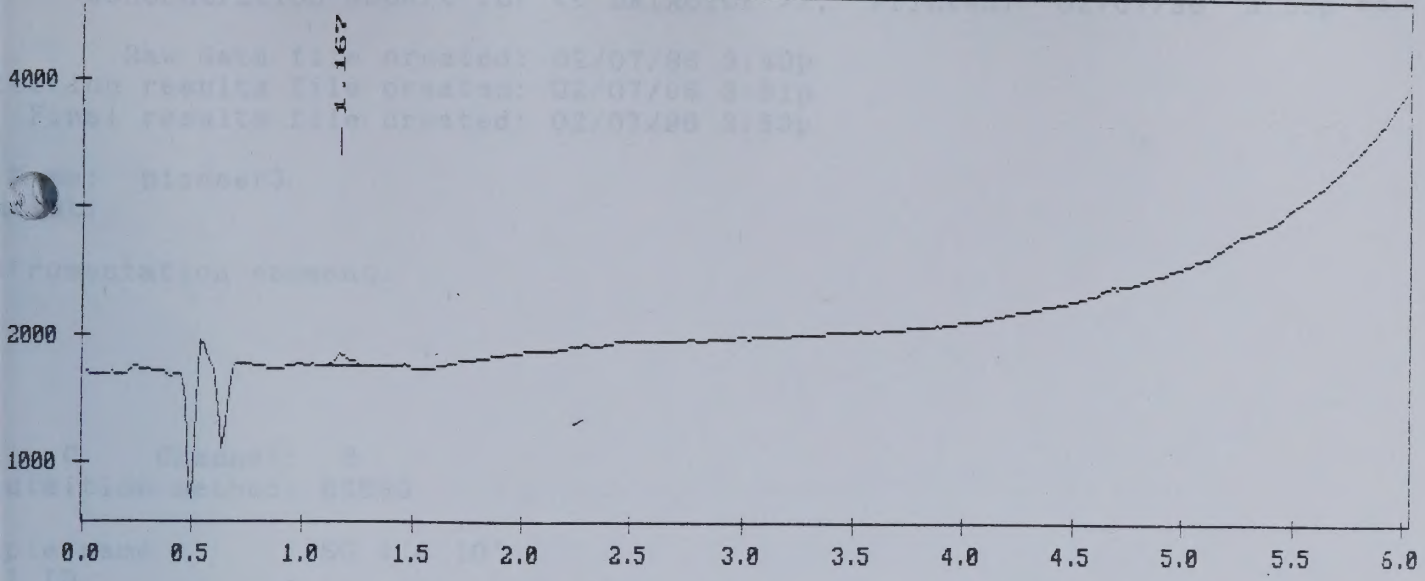
ple name : SG # 4 10'
l ID :
ection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: PIDSG
egration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ing section : created 02/05/96 11:22p, modified 02/06/96 4:27p
omatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 1
ber of components entered : 3
ber of components found : 0
ber of components not found: 3
ber of unidentified peaks : 1

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA009F 3:50p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA010F >>, Printed: 02/07/96 3:53p ***

Raw data file created: 02/07/96 3:40p
tection results file created: 02/07/96 3:51p
Final results file created: 02/07/96 3:53p

Name: pioneer3
mment:

strumentation comment:

: 0 Channel: B
quisition method: BSBSG

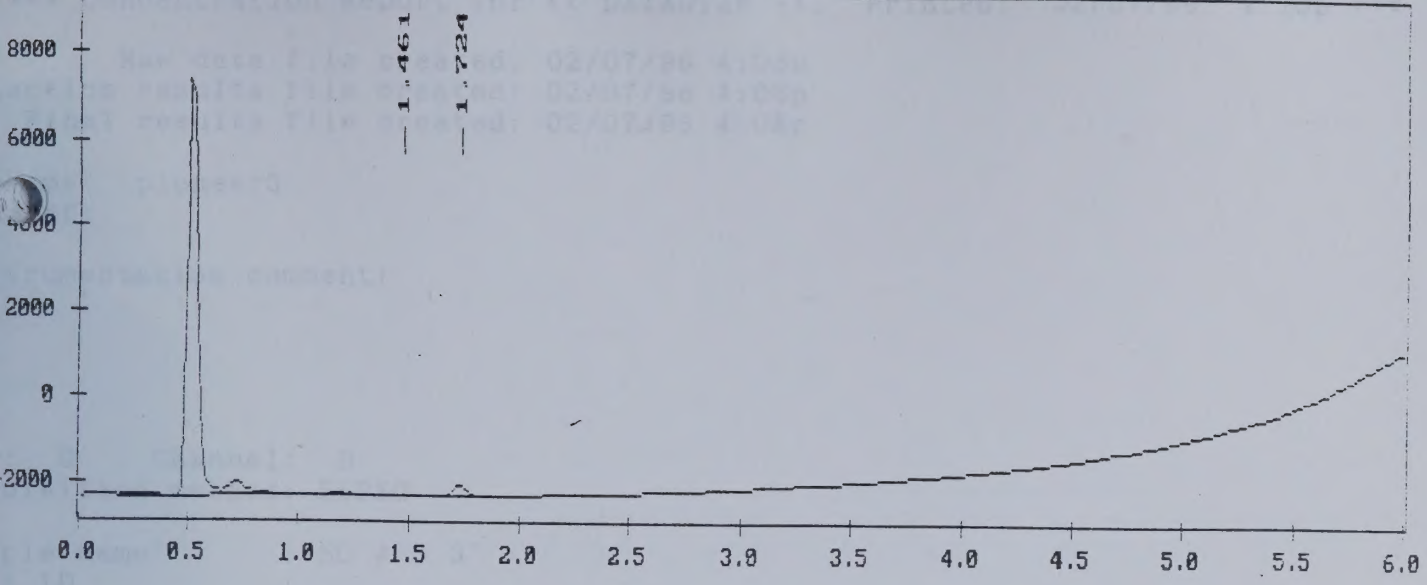
mple name : SG # 4 10'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ing section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 2
mber of components entered : 5
ber of components found : 1
mber of components not found: 4
mber of unidentified peaks : 1

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA010F 3:54p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.724	1113.20056	239.999161	1157.3291	0.961870	1.791
Cis 1,2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	850.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		1113.20056	239.999161		0.961870	

*** Concentration Report for << DATA012F >>, Printed: 02/07/96 4:10p ***

Raw data file created: 02/07/96 4:05p
tection results file created: 02/07/96 4:08p
Final results file created: 02/07/96 4:08p

me: pioneer3
nt:

strumentation comment:

t: 0 Channel: B
quisition method: BSBSG

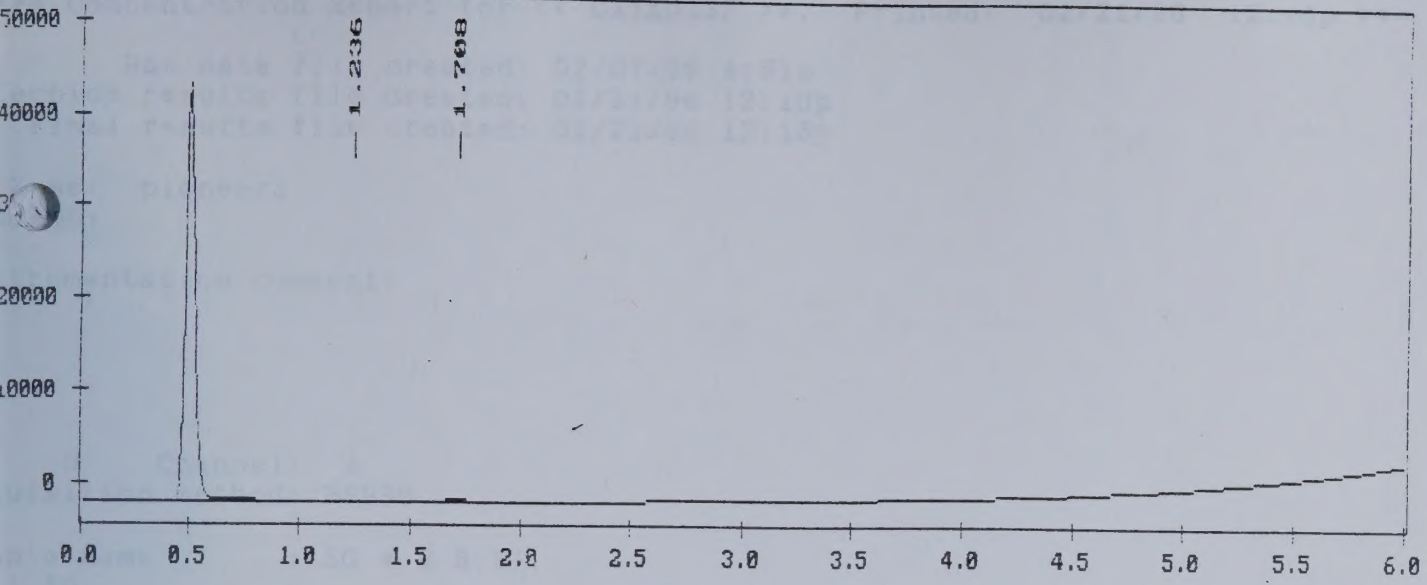
mple name : SG # 5 3'
l ID :
ection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: FIDSG
egration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ting section : created 02/05/96 11:51p, modified 02/06/96 4:26p

ber of raw data points : 360
ber of peaks detected : 2
mber of components entered : 5
ber of components found : 1
ber of components not found: 4
ber of unidentified peaks : 1

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA012F 4:11p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.708	1302.95861	258.286652	1157.3291	1.125832	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	NF	Not Found	Not Found	850.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		1302.95861	258.286652		1.125832	

*** Concentration Report for << DATA013F >>, Printed: 02/21/96 12:15p ***

Raw data file created: 02/07/96 4:51p
tection results file created: 02/21/96 12:10p
Final results file created: 02/21/96 12:15p

Name: pioneer3
mment:

strumentation comment:

: 0 Channel: A
quisition method: BSBSG

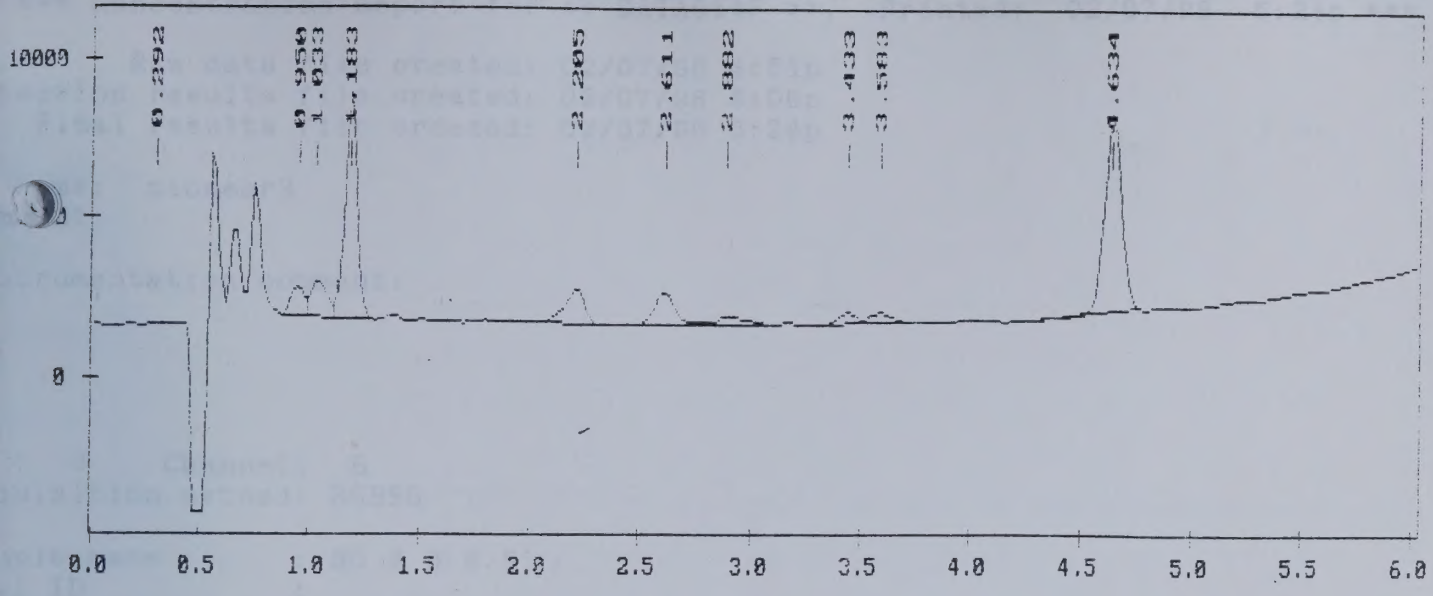
mple name : SG # 6 8.5'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: PIDSG
egration section: created 02/05/96 11:22p, modified 02/21/96 12:10p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
romatogram baseline is manually edited

ber of raw data points : 361
mber of peaks detected : 10
mber of components entered : 3
ber of components found : 2
mber of components not found: 1
mber of unidentified peaks : 8

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA013F 12:16p 02/21/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.205	7114.04150	1084.42712	1733.3886	4.104361	2.209
Trichloroethene	3.433	2219.30468	392.546783	1909.6389	1.162153	3.461
Tetrachloroethe	NF	Not Found	Not Found	1984.3660	Not Found	5.196
		9333.34570	1476.87387		5.266520	

*** Concentration Report for << DATA014F >>, Printed: 02/07/96 5:24p ***

Raw data file created: 02/07/96 4:51p
tection results file created: 02/07/96 5:06p
Final results file created: 02/07/96 5:24p

me: pioneer3
nt:

strumentation comment:

: 0 Channel: B
quisition method: BSBSG

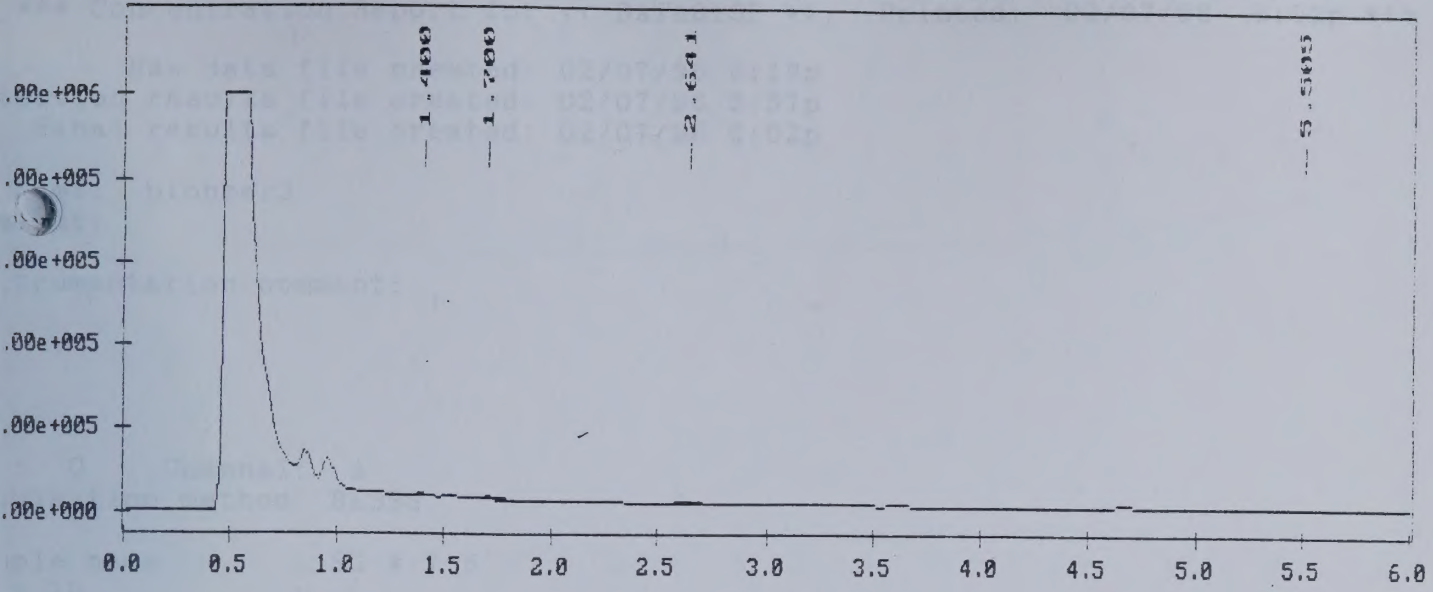
ple name : SG # 6 8.5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ing section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 4
mber of components entered : 5
ber of components found : 3
ber of components not found: 2
mber of unidentified peaks : 1

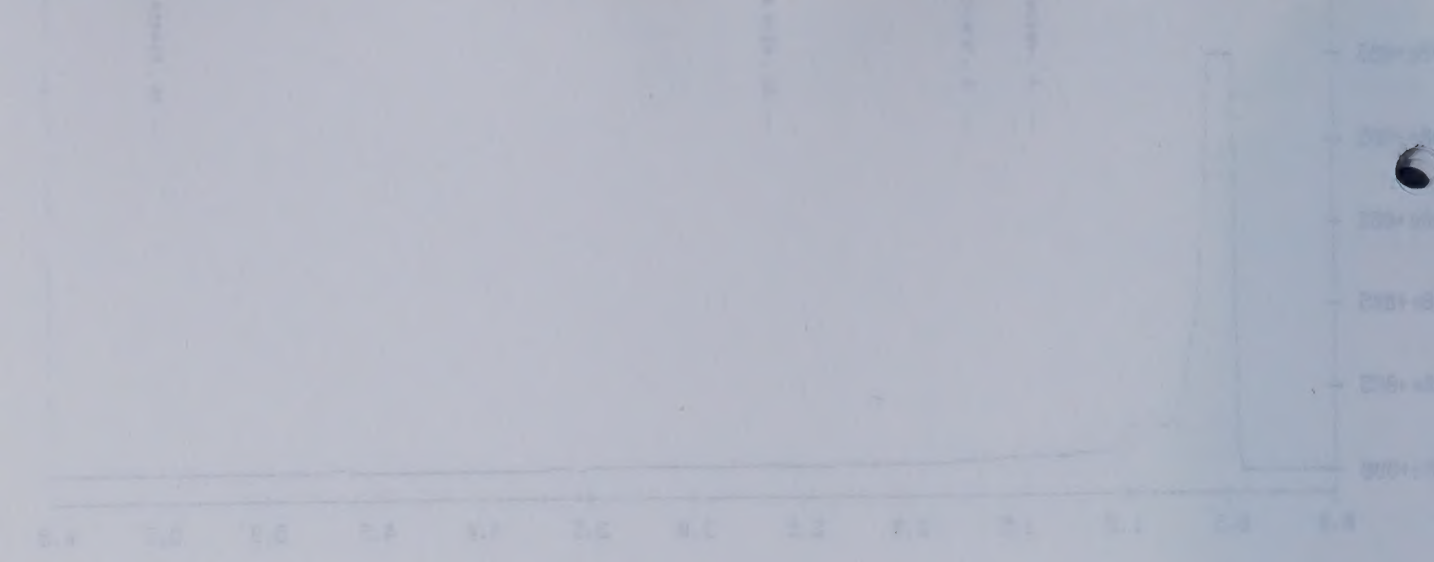
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA014F 5:25p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.700	27890.3261	6293.00048	1157.3291	24.098873	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	2.641	36166.2343	6271.90576	650.78540	55.573212	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	5.505	600.232605	75.714264	500.28051	1.199732	5.239
		64656.7968	12640.6201		80.871880	



*** Concentration Report for << DATA015F >>, Printed: 02/07/96 6:02p ***

Raw data file created: 02/07/96 5:18p
tection results file created: 02/07/96 5:57p
Final results file created: 02/07/96 6:02p

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: A
quisition method: BSBSG

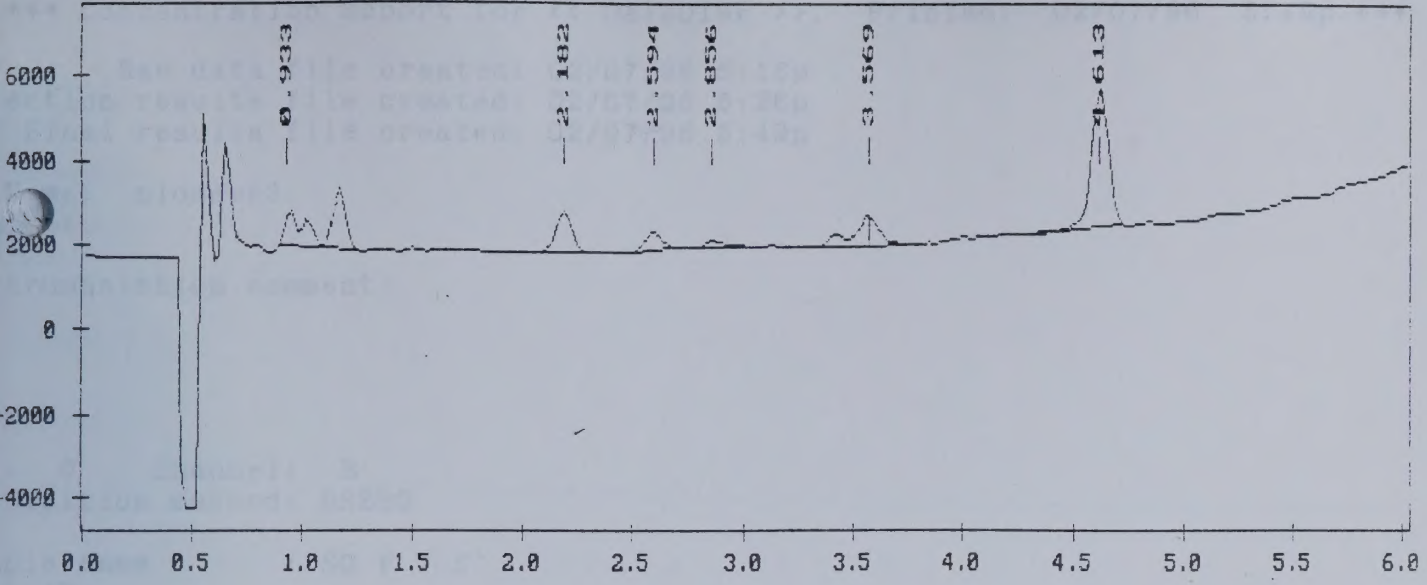
ple name : SG # 7 5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ding section : created 02/05/96 11:22p, modified 02/06/96 4:27p
romatogram baseline is manually edited

ber of raw data points : 361
mber of peaks detected : 7
mber of components entered : 3
ber of components found : 2
ber of components not found: 1
mber of unidentified peaks : 5

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA015F 6:03p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.182	4970.02392	978.989441	1733.2886	2.867395	2.209
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
Trichloroethene	3.569	4186.39306	700.479736	1909.6389	2.192243	3.461
		9156.41699	1679.46923		5.059639	

*** Concentration Report for << DATA016F >>, Printed: 02/07/96 5:49p ***

Raw data file created: 02/07/96 5:18p
tection results file created: 02/07/96 5:26p
Final results file created: 02/07/96 5:49p

Name: pioneer3
mment:

strumentation comment:

:: 0 Channel: B
quisition method: BSBSG

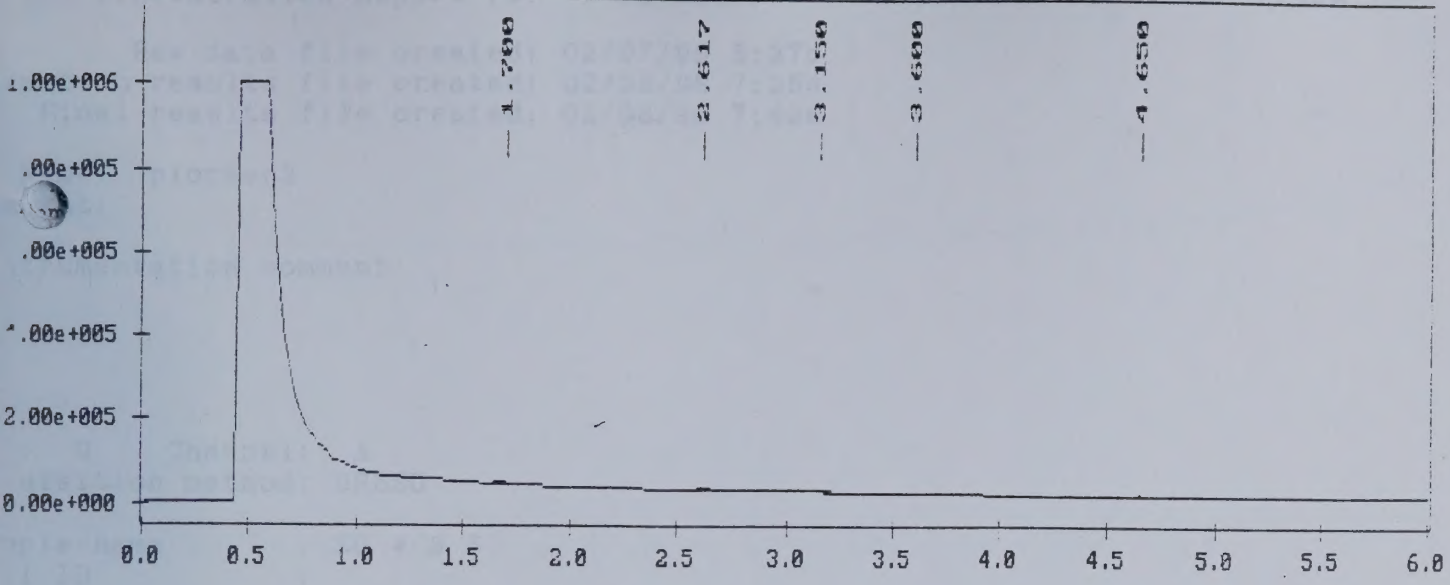
mple name : SG # 7 5'
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ding section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 5
mber of components entered : 5
ber of components found : 3
ber of components not found: 2
mber of unidentified peaks : 2

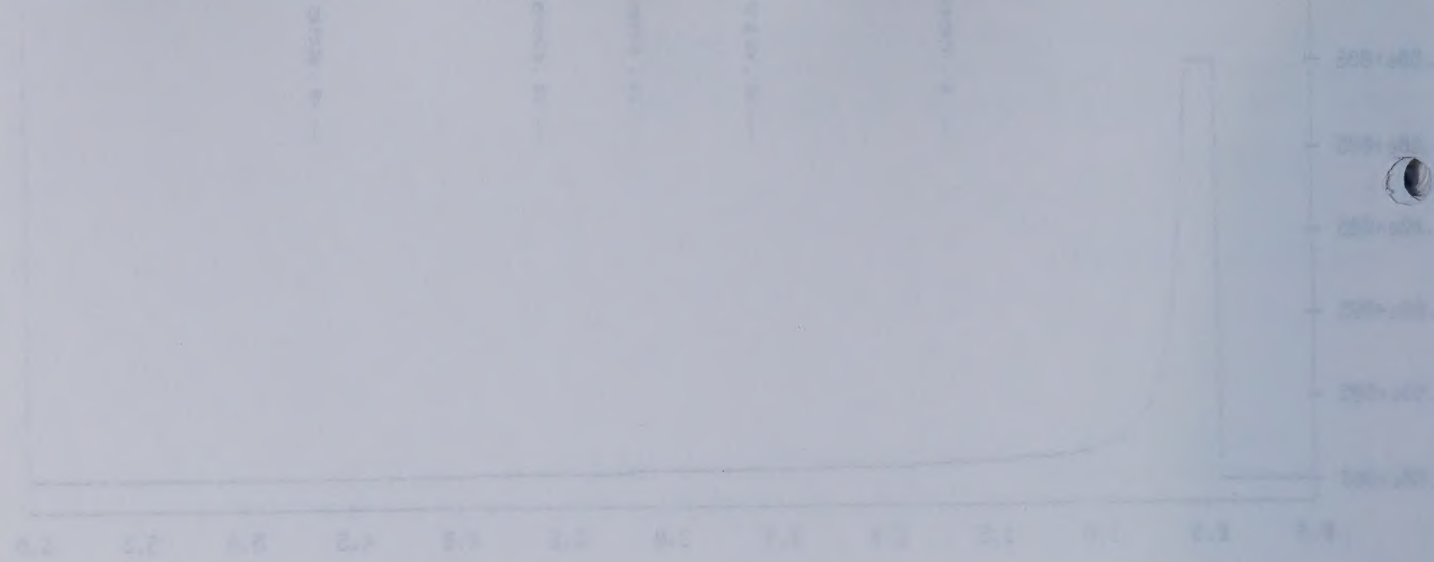
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA016F 5:50p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.700	13553.1582	3472.65039	1157.3291	11.710721	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	2.617	13897.0195	2972.54028	650.78540	21.354227	2.618
Trichloroethene	3.600	10182.1142	2040.54223	685.51977	14.853130	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		37632.2929	8485.73242		47.918079	



*** Concentration Report for << DATA017F >>, Printed: 02/08/96 7:43a ***

Raw data file created: 02/07/96 5:37p
ection results file created: 02/08/96 7:35a
Final results file created: 02/08/96 7:43a

Name: pioneer3
t:

strumentation comment:

: 0 Channel: A
uisition method: BSBSG

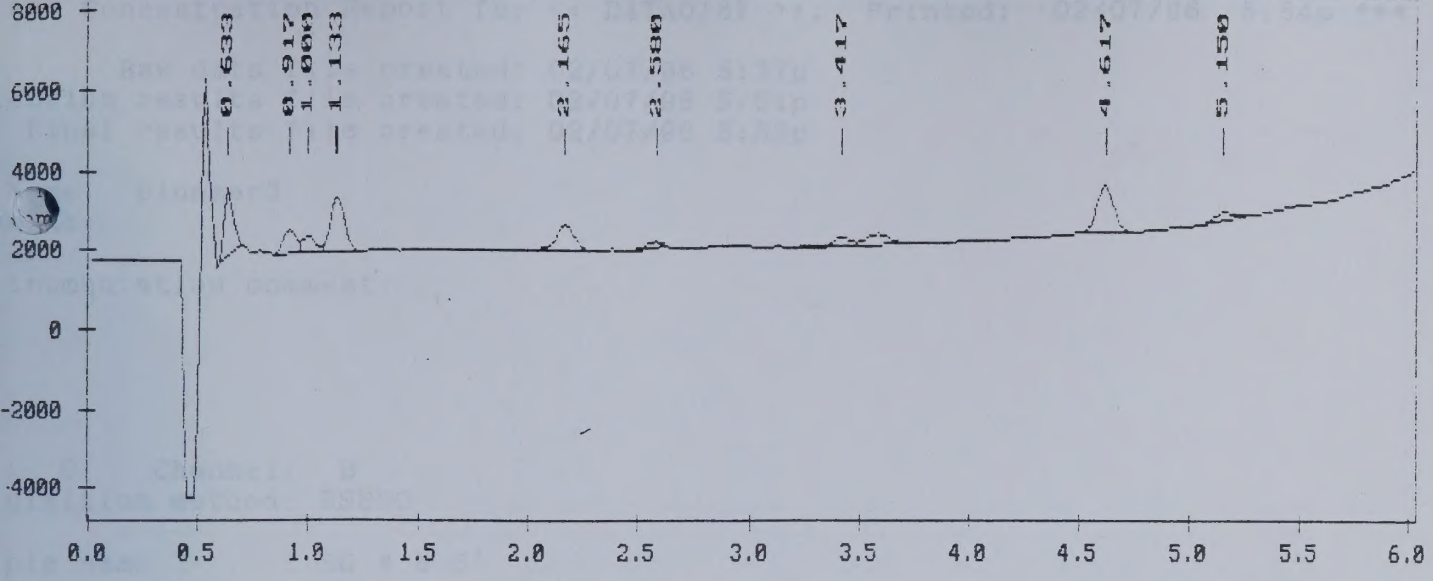
ple name : SG # 8 5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: PIDSG
egration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
togram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 9
mber of components entered : 3
ber of components found : 3
ber of components not found: 0
mber of unidentified peaks : 6

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA017F 7:45a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.165	3419.02465	643.118042	1733.2886	1.972565	2.209
Trichloroethene	3.417	3322.57348	222.999527	1909.6389	1.739896	3.461
Tetrachloroethe	5.150	1262.33264	196.428574	1384.3660	0.911949	5.196
		8003.93066	1062.54614		4.624310	

*** Concentration Report for << DATA018F >>, Printed: 02/07/96 5:54p ***

Raw data file created: 02/07/96 5:37p
tection results file created: 02/07/96 5:51p
Final results file created: 02/07/96 5:53p

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: B
quisition method: BSBSG

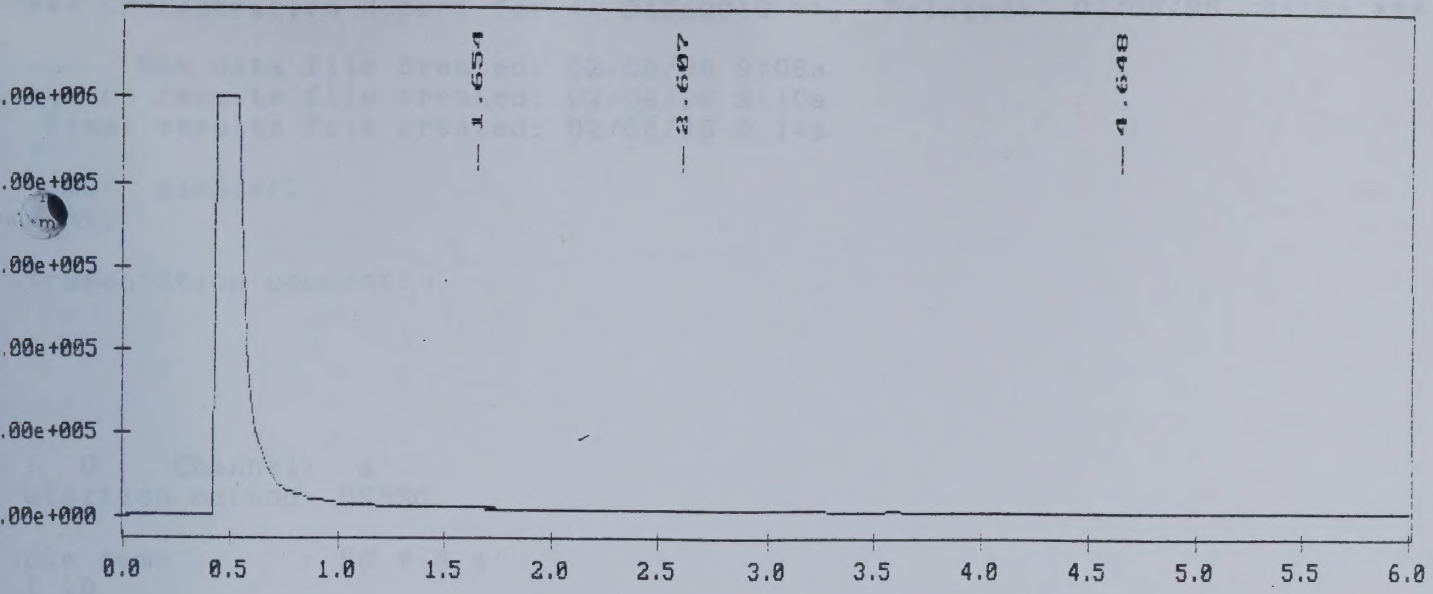
ple name : SG # 8 5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ing section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
ber of peaks detected : 3
mber of components entered : 5
ber of components found : 2
ber of components not found: 3
mber of unidentified peaks : 1

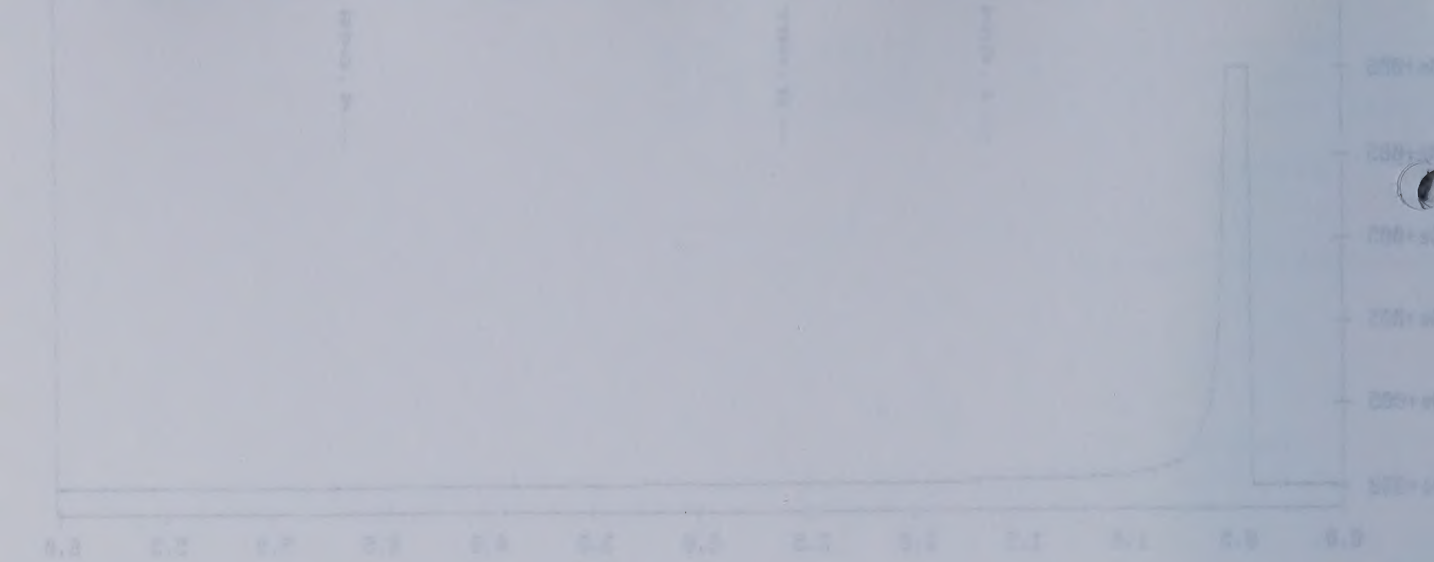
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA018F 5:55p 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.654	10603.3740	1929.66467	1157.3291	9.161935	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	2.607	4747.23388	1053.57458	650.78540	7.294622	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		15350.6074	2983.23925		16.456558	



*** Concentration Report for << DATA001G >>, Printed: 02/08/96 9:16a ***

Raw data file created: 02/08/96 9:06a
ection results file created: 02/08/96 9:10a
Final results file created: 02/08/96 9:14a

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: A
uisition method: BSBSG

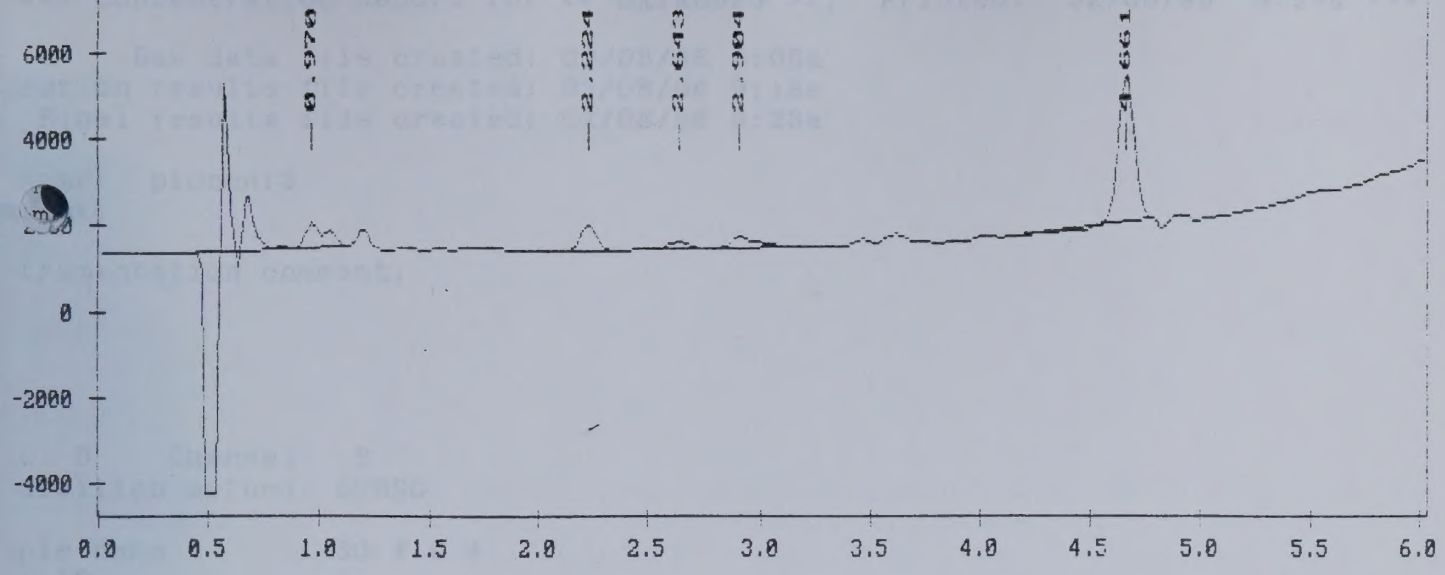
ple name : SG # 9 4'
l ID :
jection volume : 1.000000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
libration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
atogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 5
mber of components entered : 3
ber of components found : 1
ber of components not found: 2
mber of unidentified peaks : 4

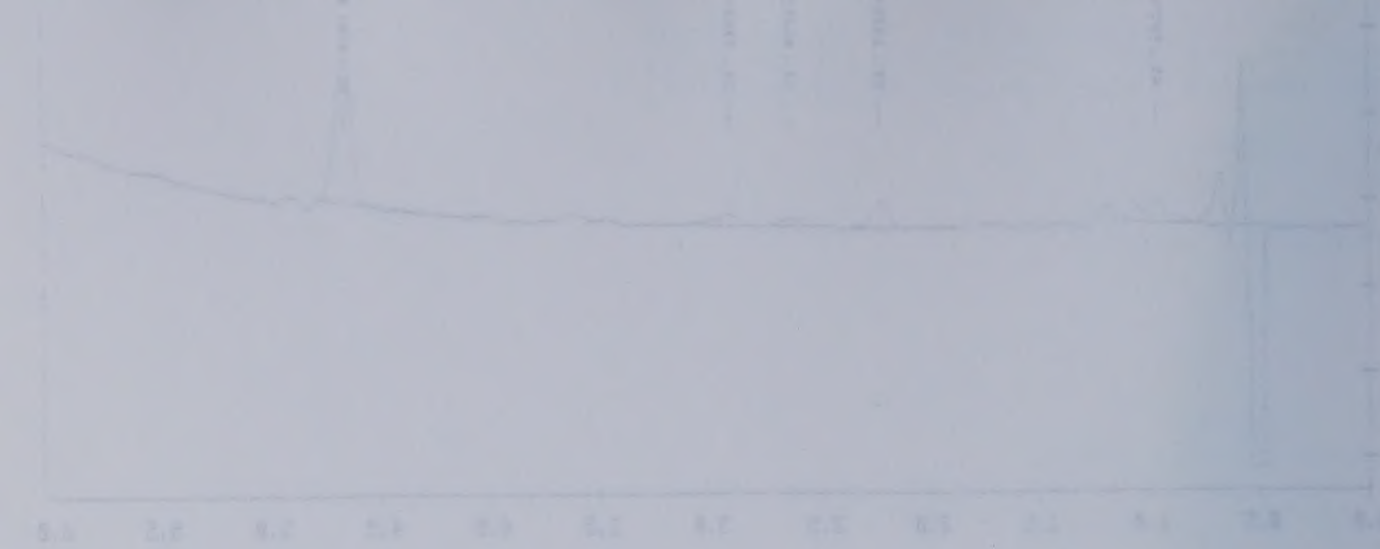
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA001G 9:17a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.224	3043.52880	596.311951	1733.2886	1.755927	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		3043.52880	596.311951		1.755927	



*** Concentration Report for << DATA002G >>, Printed: 02/08/96 9:24a ***

Raw data file created: 02/08/96 9:06a
ection results file created: 02/08/96 9:18a
Final results file created: 02/08/96 9:23a

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: B
uisition method: BSBSG

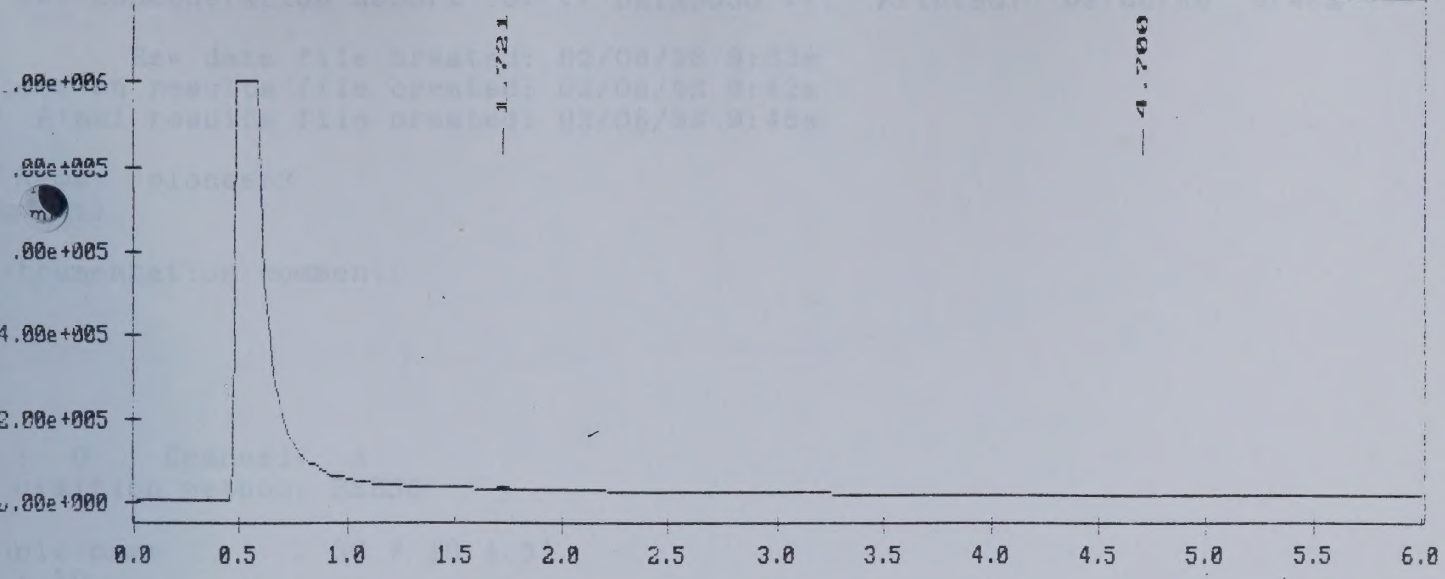
ple name : SG # 9 4'
l ID :
jection volume : 1.000000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
orting section : created 02/05/96 11:51p, modified 02/06/96 4:26p
rom.togram baseline is manually edited

ber of raw data points : 360
ber of peaks detected : 2
mber of components entered : 5
ber of components found : 1
ber of components not found: 4
mber of unidentified peaks : 1

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA002G 9:25a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.721	14647.1806	3189.58276	1157.3291	12.656020	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		14647.1806	3189.58276		12.656020	

*** Concentration Report for << DATA003G >>, Printed: 02/08/96 9:46a ***

Raw data file created: 02/08/96 9:33a
ection results file created: 02/08/96 9:42a
Final results file created: 02/08/96 9:45a

Name: pioneer3
mi t:

trumentation comment:

: 0 Channel: A
uisition method: BSBSG

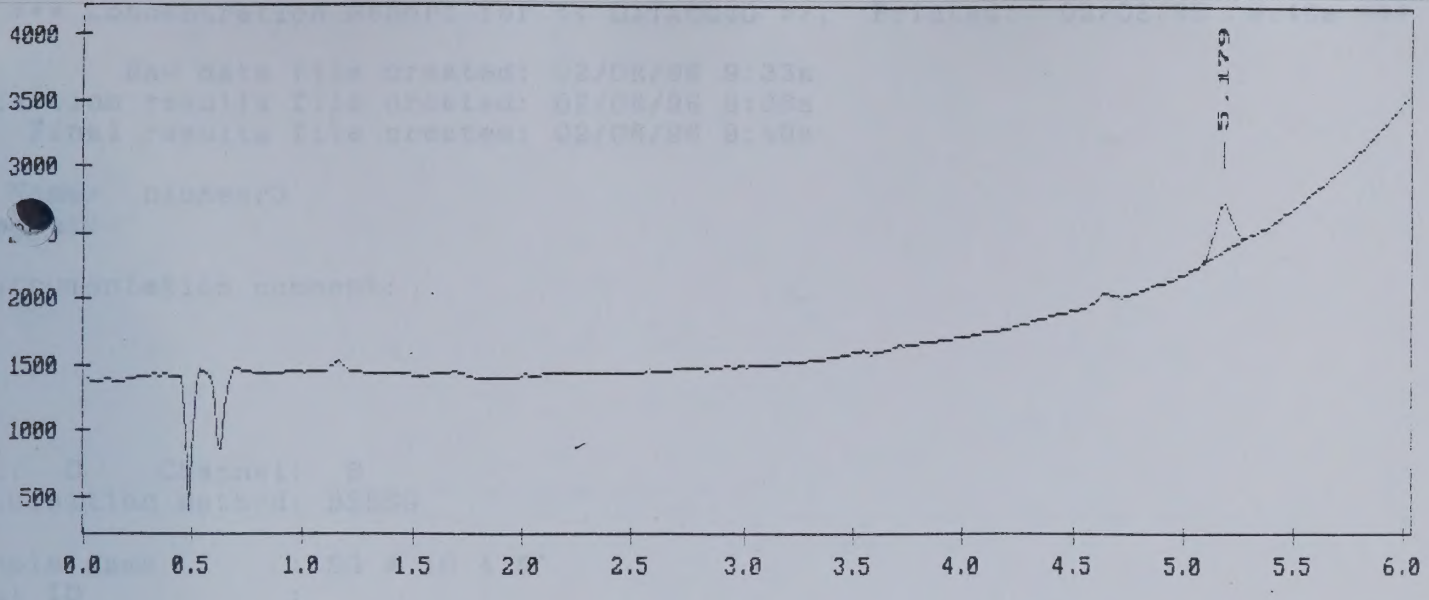
ple name : SG # 10 4.5'
.l ID :
jection volume : 1.000000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
libration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
o. togram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 1
mber of components entered : 3
ber of components found : 1
ber of components not found: 2
mber of unidentified peaks : 0

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA003G 9:47a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	5.179	2197.39111	360.746918	1384.3660	1.587291	5.196
		2197.39111	360.746918		1.587291	

*** Concentration Report for << DATA004G >>, Printed: 02/08/96 9:40a ***

Raw data file created: 02/08/96 9:33a
tection results file created: 02/08/96 9:36a
Final results file created: 02/08/96 9:40a

Name: pioneer3
mment:

strumentation comment:

:: 0 Channel: B
uisition method: BSBSG

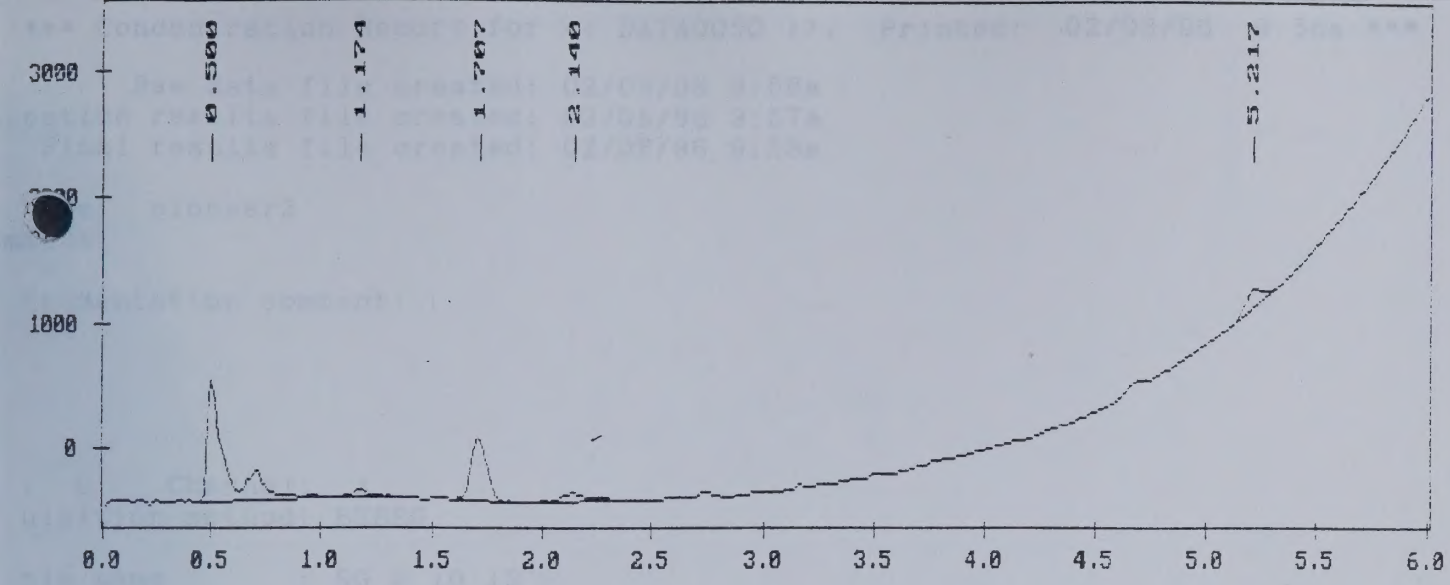
mple name : SG # 10 4.5'
al ID :
jection volume : 1.000000
amount (Sample): 0.000000
mple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ting section : created 02/05/96 11:51p, modified 02/06/96 4:26p
rom atogram baseline is manually edited

ber of raw data points : 360
ber of peaks detected : 5
mber of components entered : 5
ber of components found : 3
ber of components not found: 2
mber of unidentified peaks : 2

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA004G 9:41a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.707	2471.99145	493.741425	1157.3291	2.135945	1.791
Cis 1,2 Dichlor	2.140	664.993103	72.727272	948.04437	0.701437	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	5.217	898.666199	140.500000	500.28051	1.796325	5.239
		4035.65087	706.968689		4.633707	

*** Concentration Report for << DATA005G >>, Printed: 02/08/96 9:58a ***

Raw data file created: 02/08/96 9:56a
ection results file created: 02/08/96 9:57a
Final results file created: 02/08/96 9:58a

e: pioneer3
mment:

trumentation comment:

: 0 Channel: A
uisition method: BSBSG

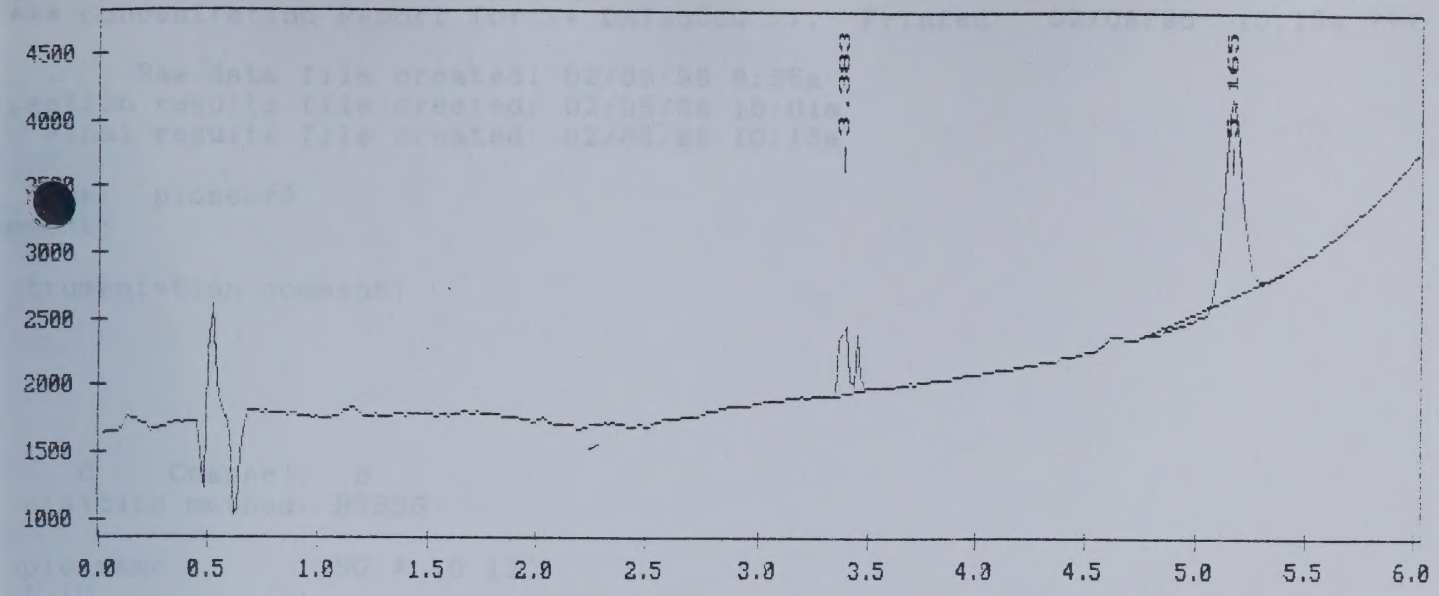
ple name : SG # 10 12'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ing section : created 02/05/96 11:22p, modified 02/06/96 4:27p
romatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 2
mber of components entered : 3
ber of components found : 2
ber of components not found: 1
mber of unidentified peaks : 0

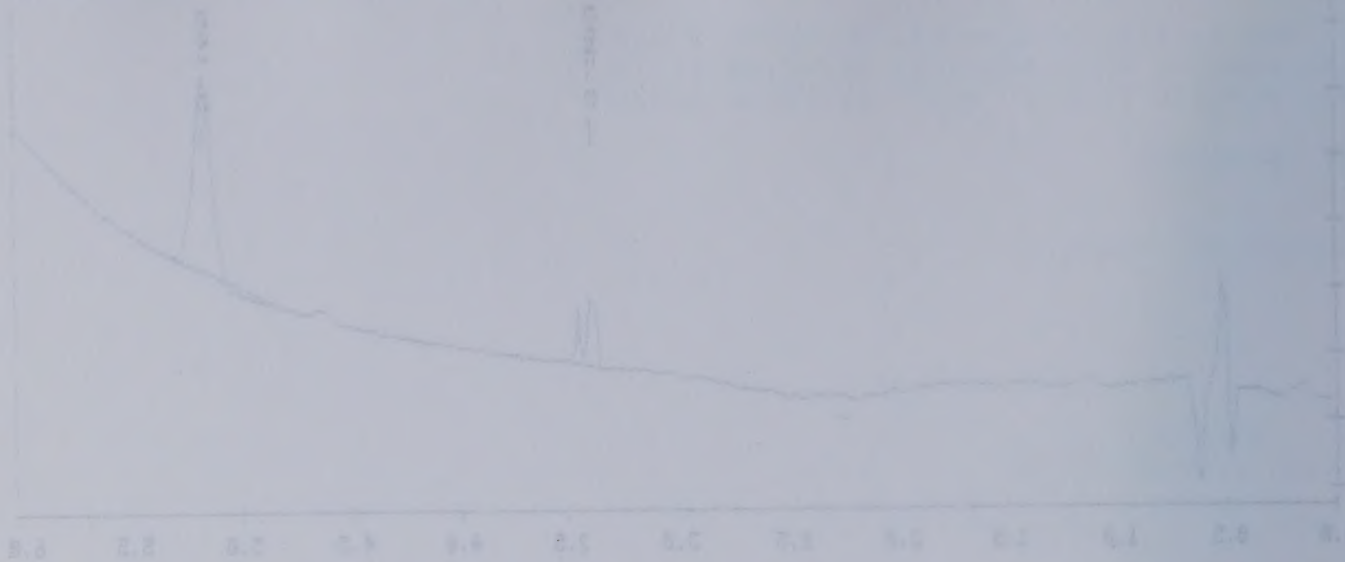
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA005G 9:59a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2986	Not Found	2.209
Trichloroethene	3.383	2099.01245	465.333862	1909.6389	1.099167	3.461
Tetrachloroethe	5.165	7767.65966	1475.82934	1384.3660	5.610987	5.196
		9866.67187	1941.16320		6.710154	



*** Concentration Report for << DATA006G >>, Printed: 02/08/96 10:15a ***

Raw data file created: 02/08/96 9:56a
ection results file created: 02/08/96 10:01a
Final results file created: 02/08/96 10:15a

e: pioneer3
mment:

trumentation comment:

: 0 Channel: B
uisition method: BSBSG

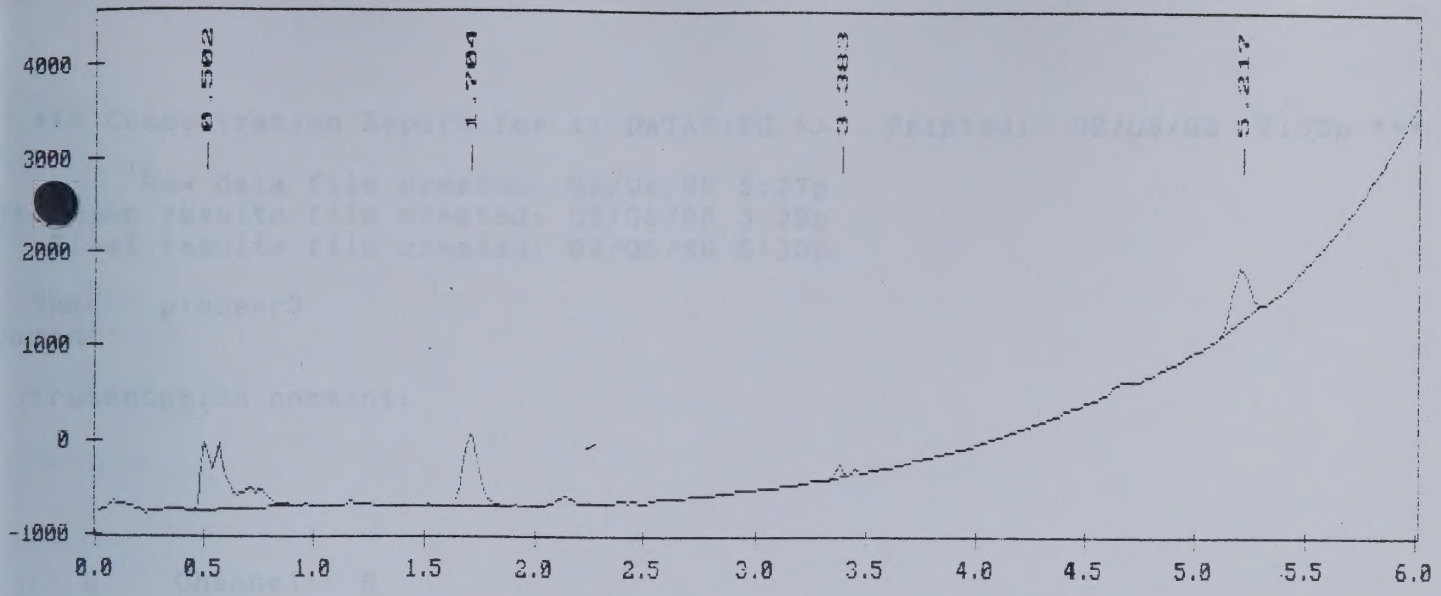
ple name : SG # 10 12'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ing section : created 02/05/96 11:51p, modified 02/06/96 4:26p
omatogram baseline is manually edited

ber of raw data points : 360
ber of peaks detected : 4
mber of components entered : 5
ber of components found : 3
ber of components not found: 2
mber of unidentified peaks : 1

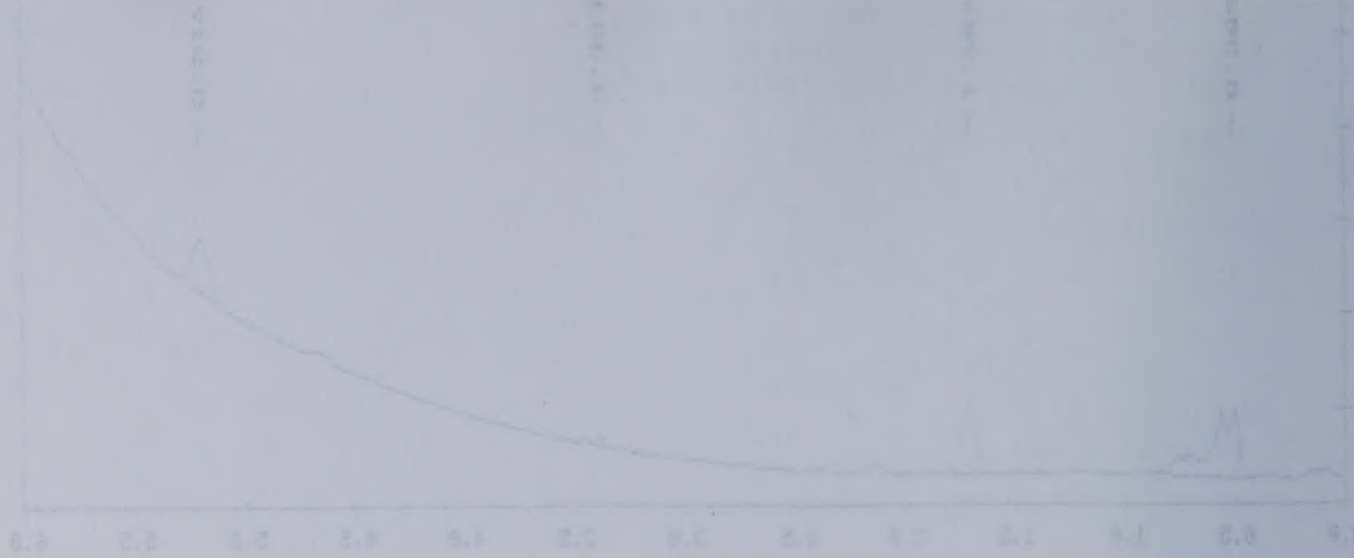
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA006G 10:16a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.704	4010.98315	774.629456	1157.3291	3.465724	1.791
Cis 1,2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	3.383	305.944824	131.599930	685.51977	0.446296	3.499
Tetrachloroethe	5.217	3222.17578	526.666809	500.28051	6.440738	5.239
		7539.10351	1432.89624		10.352758	



*** Concentration Report for << DATA016G >>, Printed: 02/08/96 5:30p ***

Raw data file created: 02/08/96 5:27p
ation results file created: 02/08/96 5:28p
Final results file created: 02/08/96 5:30p

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: B
quisition method: BSBSG

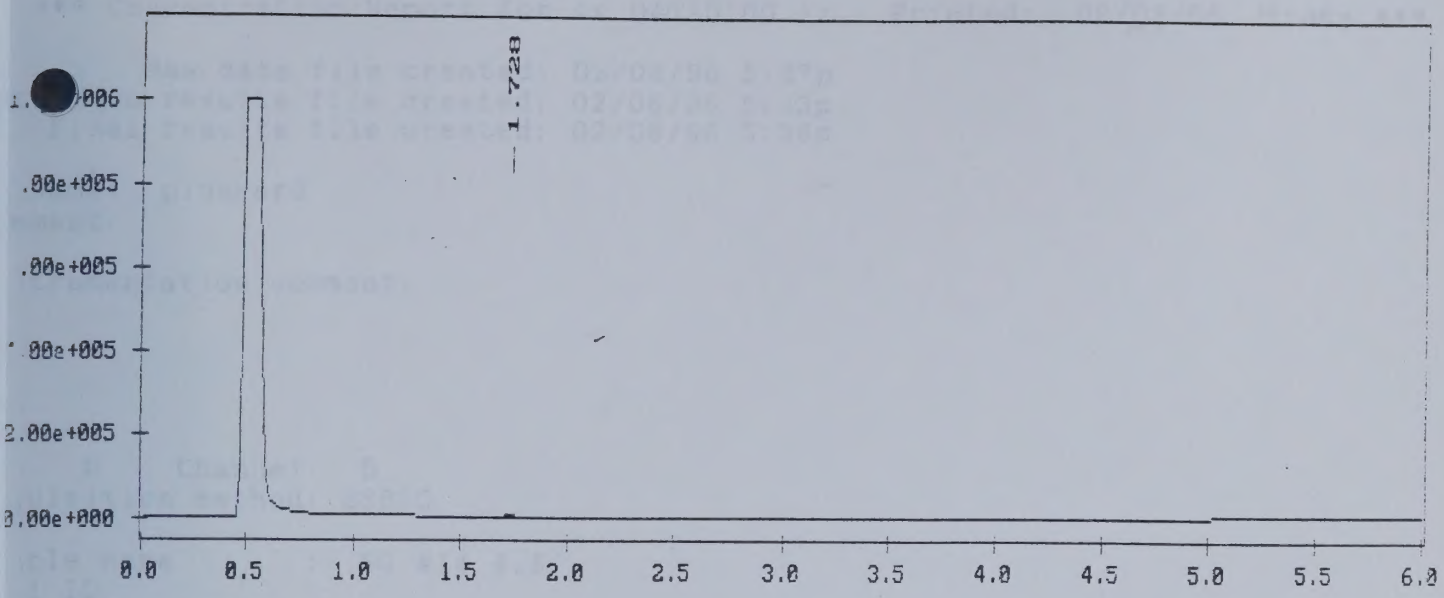
ple name : SG #14 4.5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
orting section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 1
mber of components entered : 5
ber of components found : 1
ber of components not found: 4
mber of unidentified peaks : 0

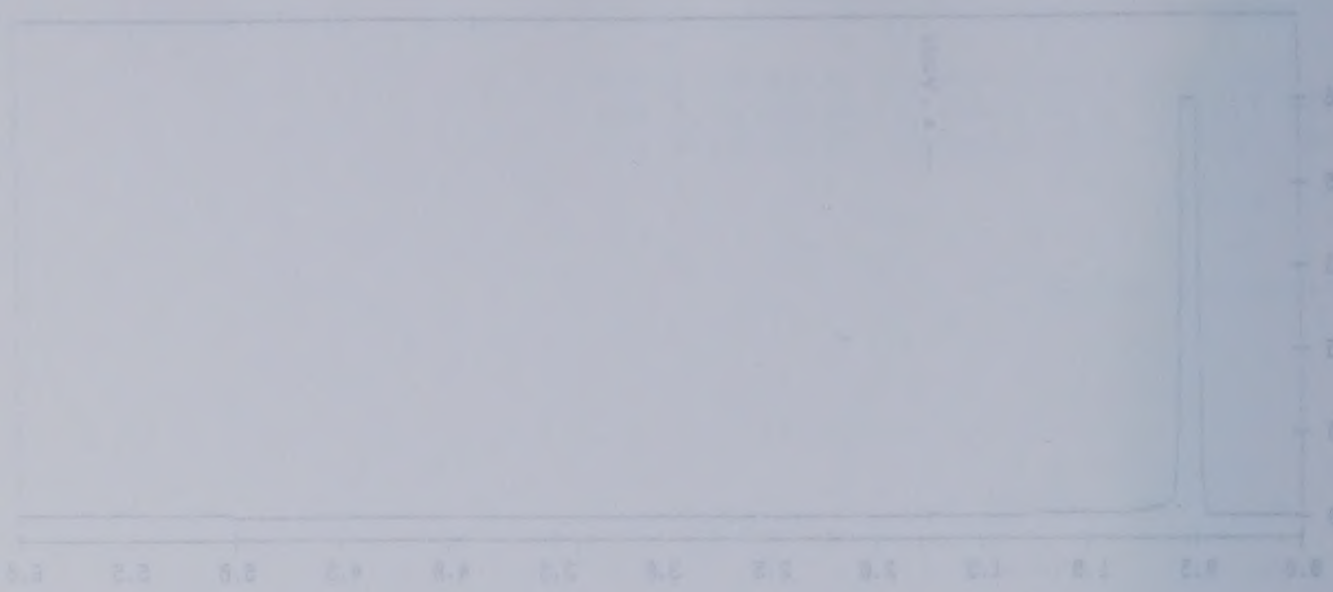
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA016G 5:31p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.728	1374.50170	441.648895	1157.3291	1.187650	1.791
Cis 1,2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51877	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		1374.50170	441.648895		1.187650	



*** Concentration Report for << DATA016G >>, Printed: 02/08/96 5:36p ***

Raw data file created: 02/08/96 5:27p
tion results file created: 02/08/96 5:33p
Final results file created: 02/08/96 5:36p

Name: pioneer3
mment:

trumentation comment:

: 0 Channel: B
quisition method: BSBSG

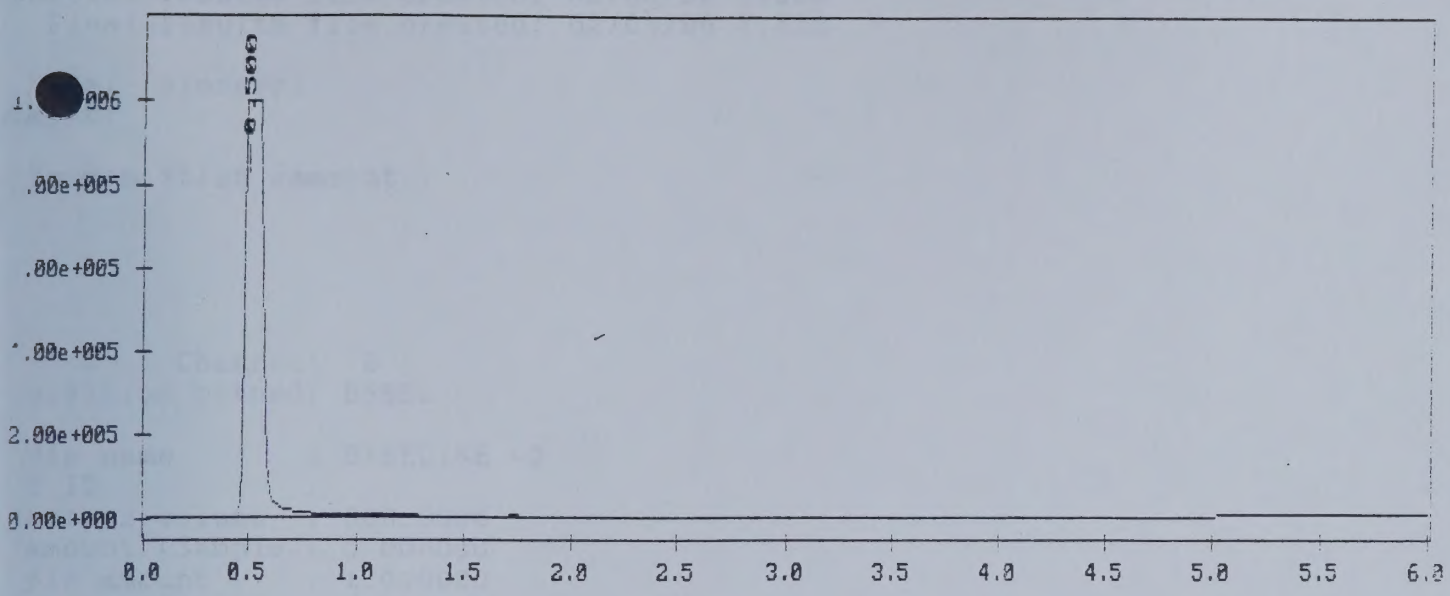
ple name : SG #14 4.5'
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

sing method: METHANE
tegration section: created 02/06/96 4:28p, modified 02/06/96 8:05p
ibration section: created 02/06/96 4:28p, modified 02/06/96 7:42p
orting section : created 02/06/96 4:28p, modified 02/06/96 4:29p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 1
mber of components entered : 1
ber of components found : 1
ber of components not found: 0
mber of unidentified peaks : 0

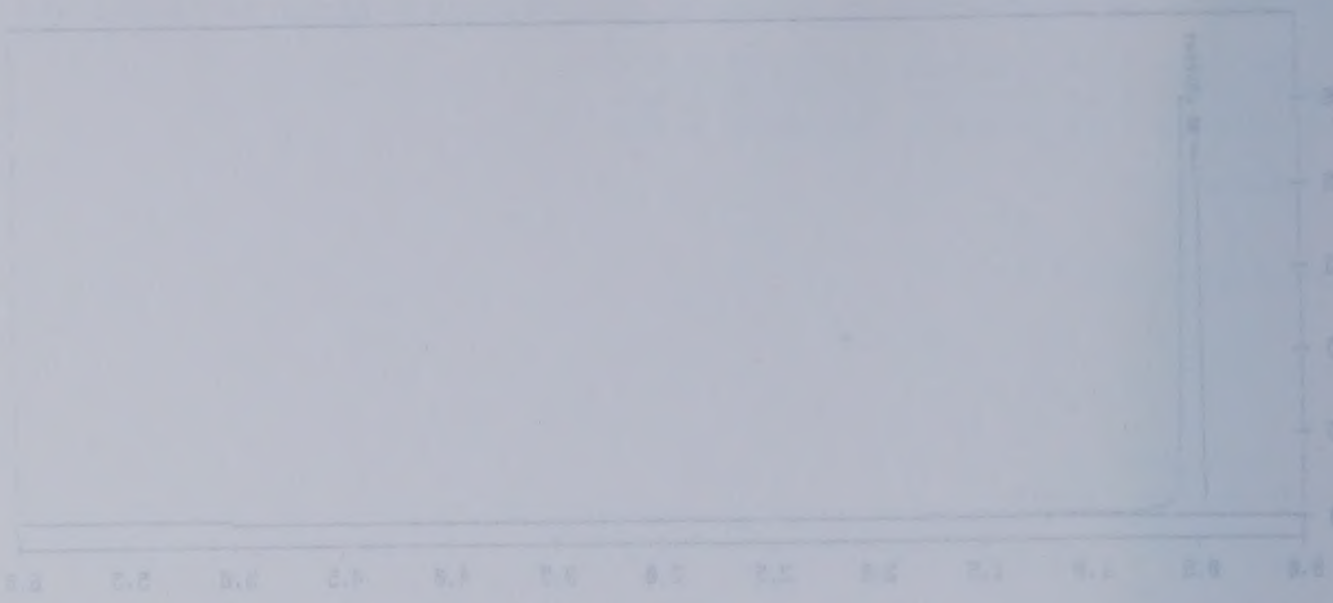
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA016G 5:37p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Methane	0.503	6031473.00	997172.250	5696.2685	1058.946313	0.483
		6031473.00	997172.250		1058.946313	



*** Concentration Report for << DATA020F >>, Printed: 02/08/96 7:53a ***

Raw data file created: 02/07/96 6:11p
ection results file created: 02/08/96 7:50a
Final results file created: 02/08/96 7:52a

e: pioneer3
mment:

trumentation comment:

: 0 Channel: B
uisition method: BSBSG

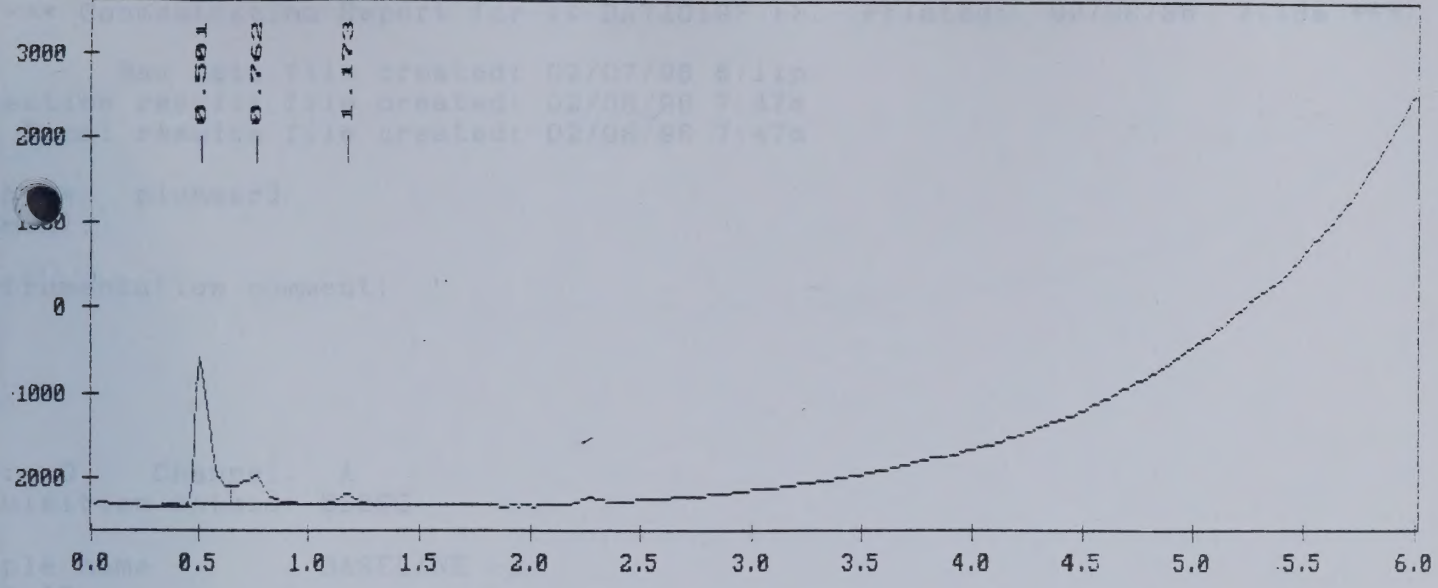
ple name : BASELINE -2
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
libration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
ing section : created 02/05/96 11:51p, modified 02/06/96 4:26p
romatogram baseline is manually edited

ber of raw data points : 360
ber of peaks detected : 3
mber of components entered : 5
ber of components found : 0
ber of components not found: 5
mber of unidentified peaks : 3

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA020F 7:54a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	NF	Not Found	Not Found	1157.3291	Not Found	1.791
Cis 1.2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1.1.1 Trichloro	NF	Not Found	Not Found	850.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA019F >>, Printed: 02/08/96 7:48a ***

Raw data file created: 02/07/96 6:11p
ection results file created: 02/08/96 7:47a
Final results file created: 02/08/96 7:47a

e: pioneer3
ment:

trumentation comment:

: 0   Channel: A
uisition method: BSBSG

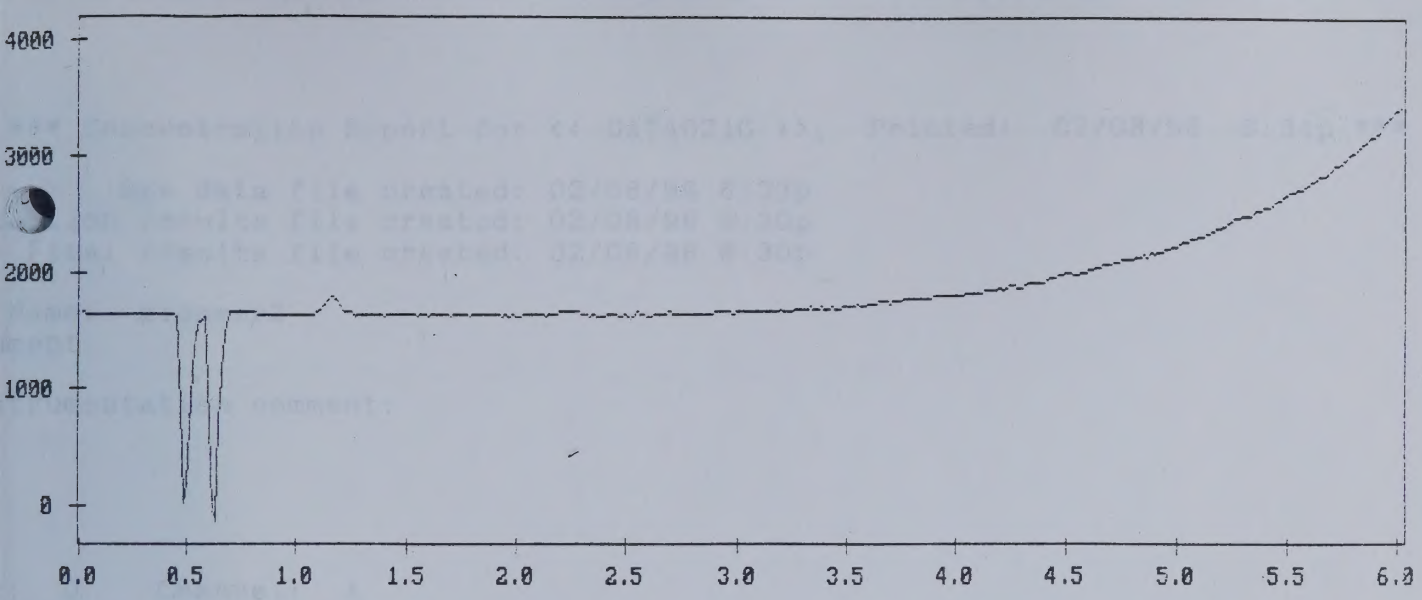
ple name   : BASELINE -2
l ID   :
ection volume : 500.0000
amount (Sample): 0.000000
ple amount   : 1.000000
ution factor   : 1.000000

amount (Calib)   : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: PIDSG
egration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
ing section : created 02/05/96 11:22p, modified 02/06/96 4:27p
omatogram baseline is manually edited

ber of raw data points   : 361
ber of peaks detected   : 0
ber of components entered : 3
ber of components found   : 0
ber of components not found: 3
ber of unidentified peaks : 0

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA019F 7:49a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1,2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3680	Not Found	5.196
		0.000000	0.000000		0.000000	

*** Concentration Report for << DATA021G >>, Printed: 02/08/96 6:31p ***

Raw data file created: 02/08/96 6:23p
ion results file created: 02/08/96 6:30p
Final results file created: 02/08/96 6:30p

Name: pioneer3
mment:

strumentation comment:

: 0 Channel: A
quisition method: BSBSG

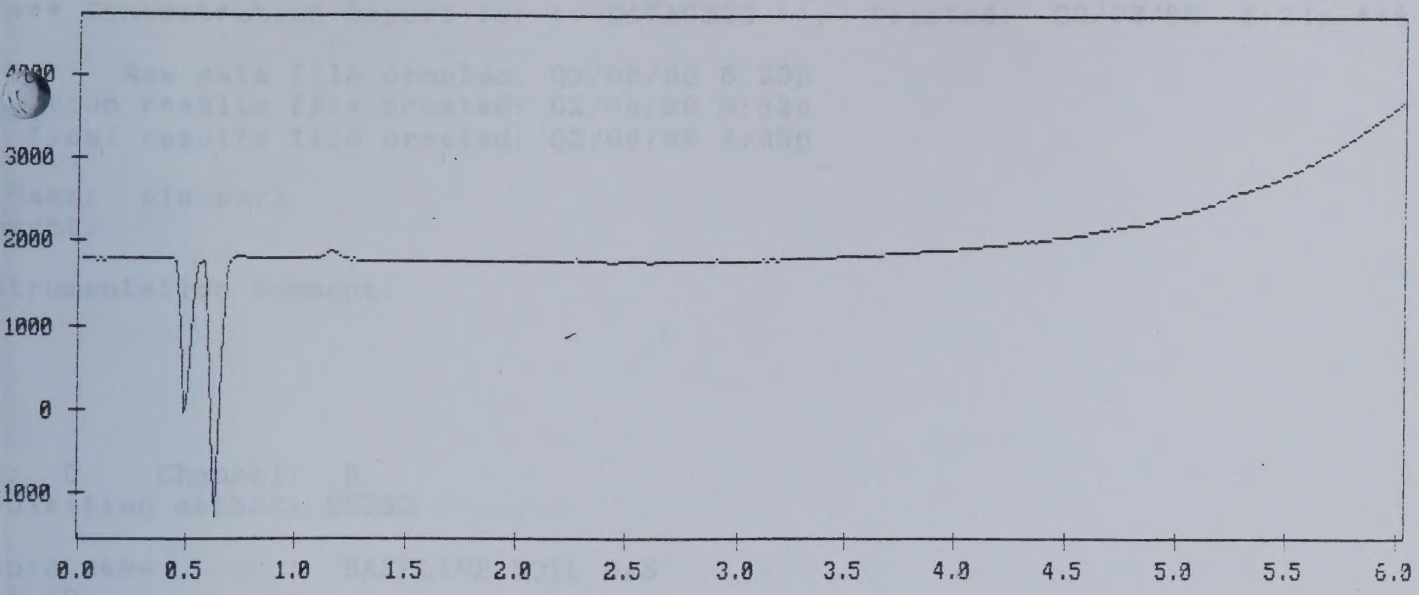
ple name : BASELINE SOIL GAS
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDSG
tegration section: created 02/05/96 11:22p, modified 02/05/96 11:23p
ibration section: created 02/05/96 11:22p, modified 02/05/96 11:49p
orting section : created 02/05/96 11:22p, modified 02/06/96 4:27p
romatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 0
mber of components entered : 3
ber of components found : 0
ber of components not found: 3
mber of unidentified peaks : 0

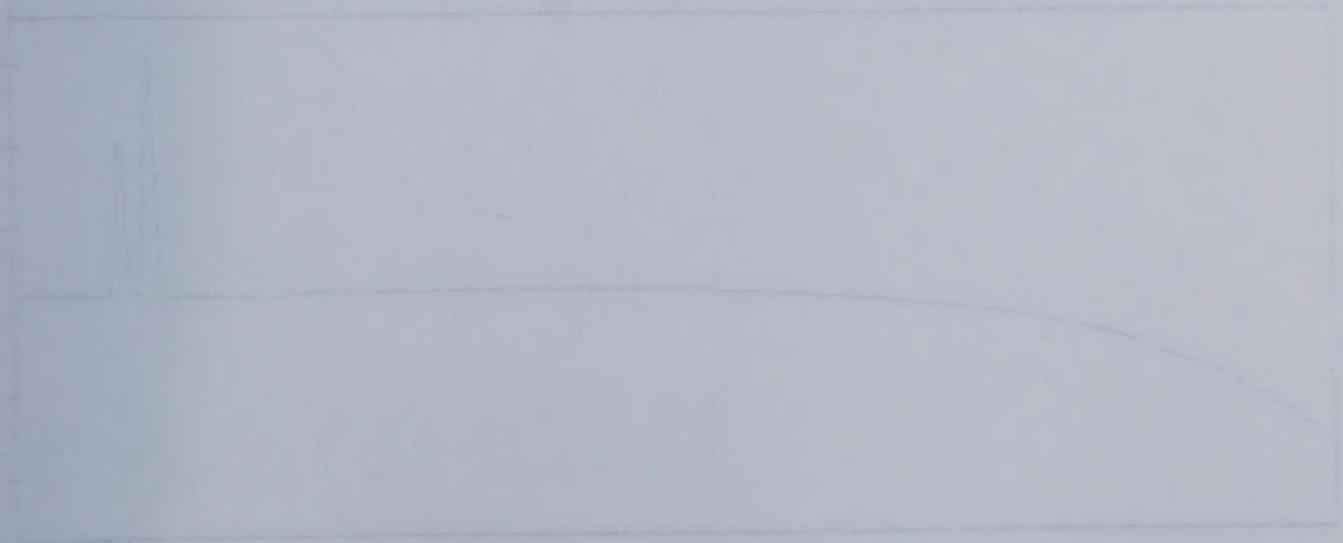
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA021G 6:32p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	NF	Not Found	Not Found	1733.2886	Not Found	2.209
Trichloroethene	NF	Not Found	Not Found	1909.6389	Not Found	3.461
Tetrachloroethe	NF	Not Found	Not Found	1384.3660	Not Found	5.196
		0.000000	0.000000		0.000000	



*** Concentration Report for << DATA022G >>, Printed: 02/08/96 6:34p ***

Raw data file created: 02/08/96 6:23p
tion results file created: 02/08/96 6:33p
Final results file created: 02/08/96 6:33p

Name: pioneer3
mment:

strumentation comment:

: 0   Channel: B
quisition method: BSBSG

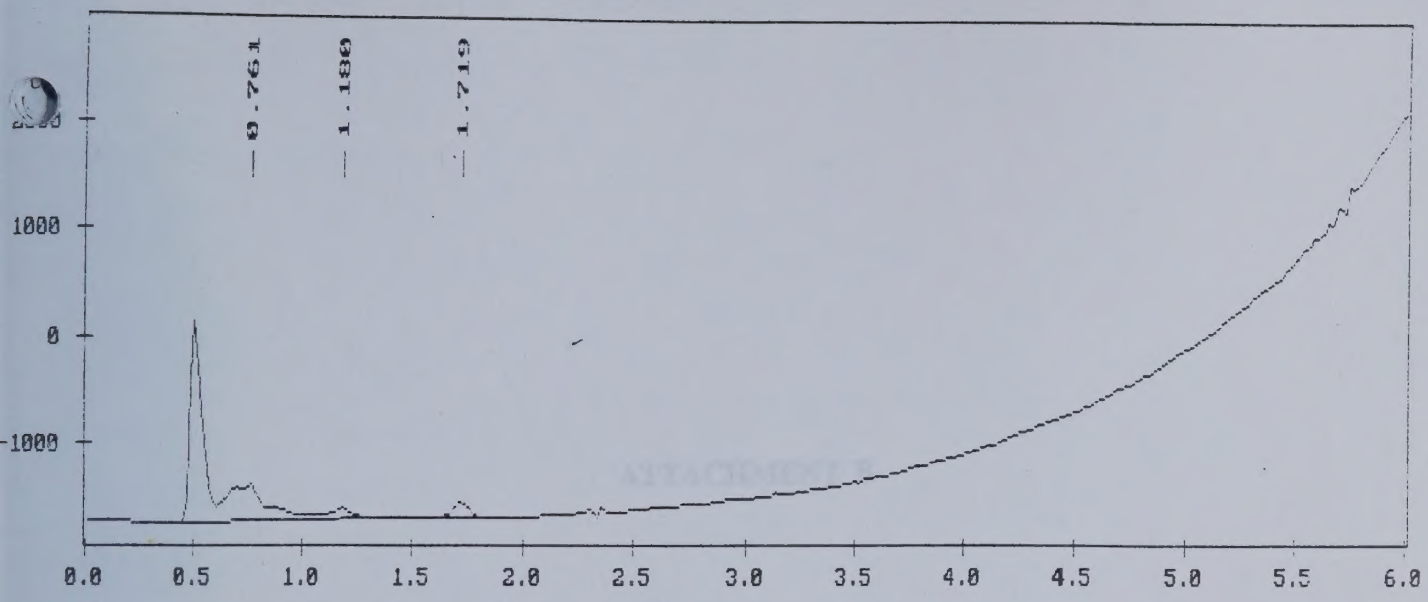
ple name   : BASELINE SOIL GAS
l ID   :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount   : 1.000000
lution factor   : 1.000000

amount (Calib)   : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

ssing method: FIDSG
tegration section: created 02/05/96 11:51p, modified 02/07/96 9:04a
ibration section: created 02/05/96 11:51p, modified 02/06/96 12:52a
orting section : created 02/05/96 11:51p, modified 02/06/96 4:26p

mber of raw data points   : 360
ber of peaks detected   : 3
mber of components entered : 5
mber of components found   : 1
ber of components not found: 4
ber of unidentified peaks : 2

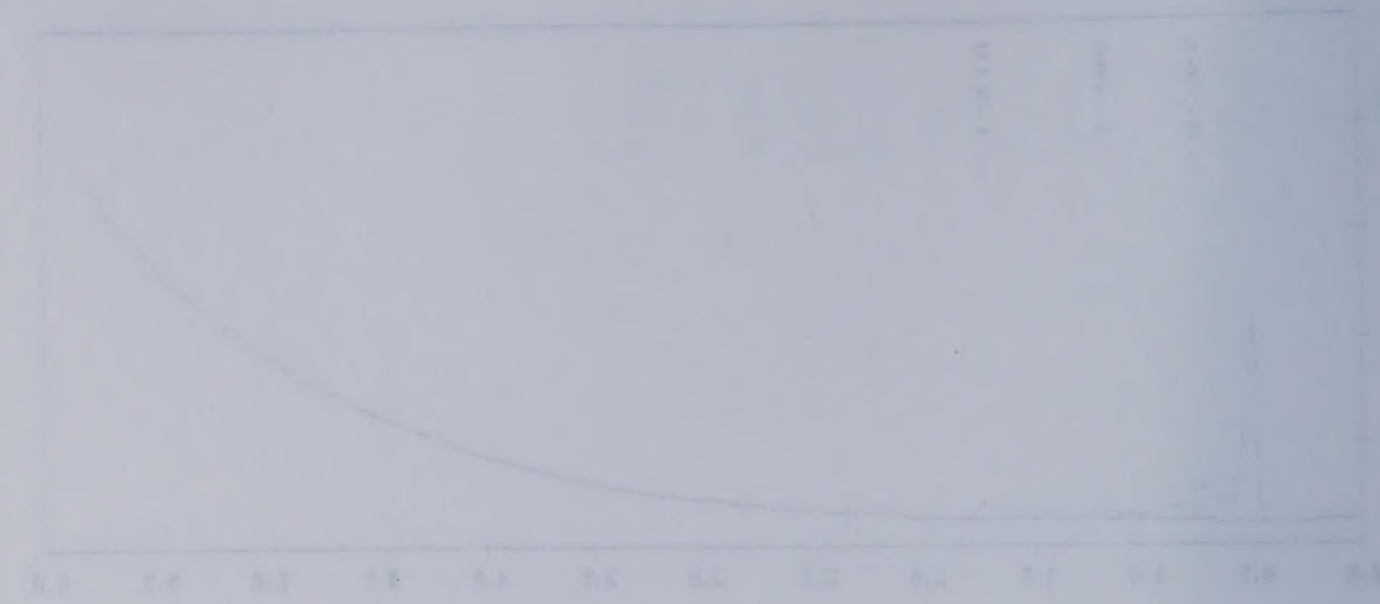
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA022G 6:35p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.719	700.969055	142.980774	1157.3291	0.605678	1.791
Cis 1,2 Dichlor	NF	Not Found	Not Found	948.04437	Not Found	2.233
1,1,1 Trichloro	NF	Not Found	Not Found	650.78540	Not Found	2.618
Trichloroethene	NF	Not Found	Not Found	685.51977	Not Found	3.499
Tetrachloroethe	NF	Not Found	Not Found	500.28051	Not Found	5.239
		700.969055	142.980774		0.605678	



ATTACHMENT B

Raw data file created: 02/07/96 10:58a
tection results file created: 02/07/96 10:59a
Final results file created: 02/07/96 10:59a

Name: pioneer3
nt:

strumentation comment:

ox: 0 Channel: A
quisition method: BSBSG

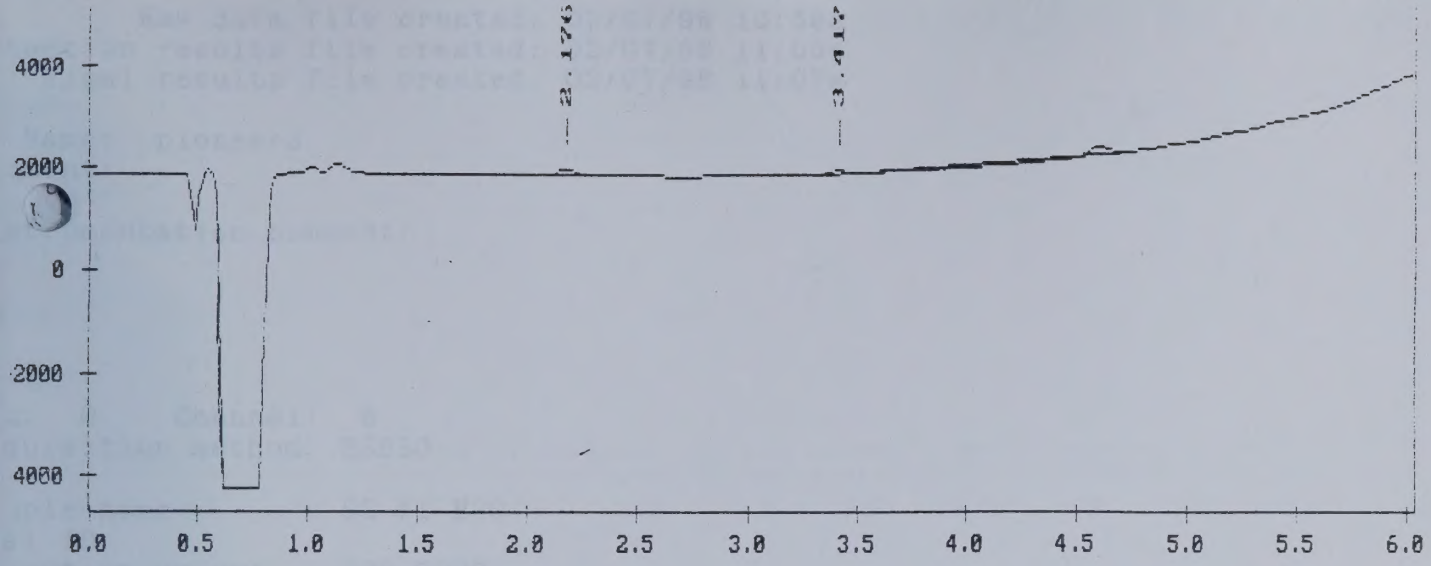
mple name : SG #1 H20
al ID :
jection volume : 500.0000
S amount (Sample): 0.000000
mple amount : 1.000000
.ution factor : 1.000000

S amount (Calib) : 0.000000
. amount multiplier: 1.000000
. response factor : 1.000000

cessing method: PIDH20
egration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
libration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
porting section : created 02/05/96 12:58p, modified 02/05/96 10:11p

mber of raw data points : 361
mber of peaks detected : 2
ber of components entered : 3
...ber of components found : 2
mber of components not found: 1
ber of unidentified peaks : 0

perior peak labels: Retention Time



FULL REPORT

Raw data file : DATA005F 11:02a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.176	902.540894	131.251556	533.91748	1.690413	2.222
Trichloroethene	3.417	410.273132	67.767128	936.93689	0.437888	3.479
Tetrachloroethe	NF	Not Found	Not Found	848.60638	Not Found	5.212
		1312.81396	199.018677		2.128300	

```
      Raw data file created: 02/07/96 10:58a
tection results file created: 02/07/96 11:05a
  Final results file created: 02/07/96 11:07a

 Name:  pioneer3
ament:

strumentation comment:



x:  0    Channel:  B
quisition method: BSBSG

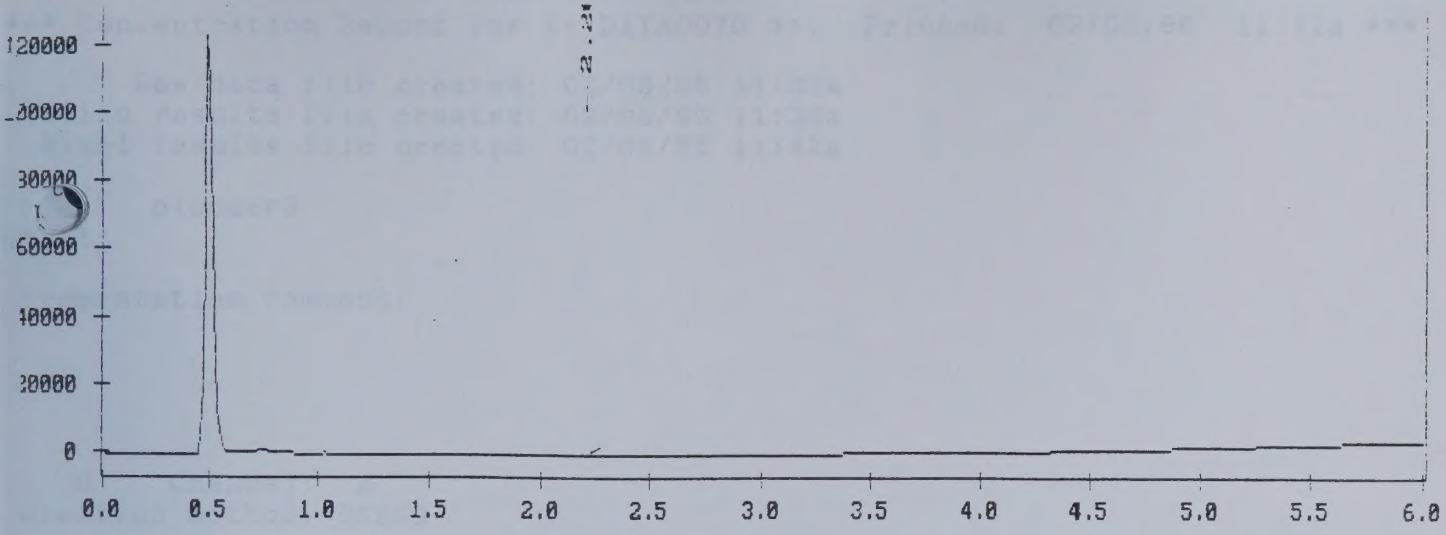
iple name       : SG #1 H2O
al ID           :
ection volume   : 500.0000
 amount (Sample): 0.000000
mple amount     : 1.000000
lution factor   : 1.000000

 amount (Calib)     : 0.000000
j. amount multiplier: 1.000000
 . response factor  : 1.000000

ocessing method: FIDH2O
egration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
 ibration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
porting section  : created 02/05/96 1:08p, modified 02/05/96 10:09p
romatogram baseline is manually edited

mber of raw data points      : 360
mber of peaks detected       : 1
 ber of components entered   : 5
 ber of components found     : 1
mber of components not found: 4
 ber of unidentified peaks   : 0

perior peak labels: Retention Time
```



FULL REPORT

Raw data file : DATA006F 11:09a 02/07/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	NF	Not Found	Not Found	354.02630	Not Found	1.816
Cis 1.2-Dichlor	2.208	1127.95996	122.654320	307.17486	3.672045	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	NF	Not Found	Not Found	345.85070	Not Found	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		1127.95996	122.654320		3.672045	

*** Concentration Report for << DATA007G >>, Printed: 02/08/96 11:42a ***

Raw data file created: 02/08/96 11:33a
ection results file created: 02/08/96 11:35a
Final results file created: 02/08/96 11:42a

: pioneer3
mment:

trumentation comment:

: 0 Channel: A
uisition method: BSBSG

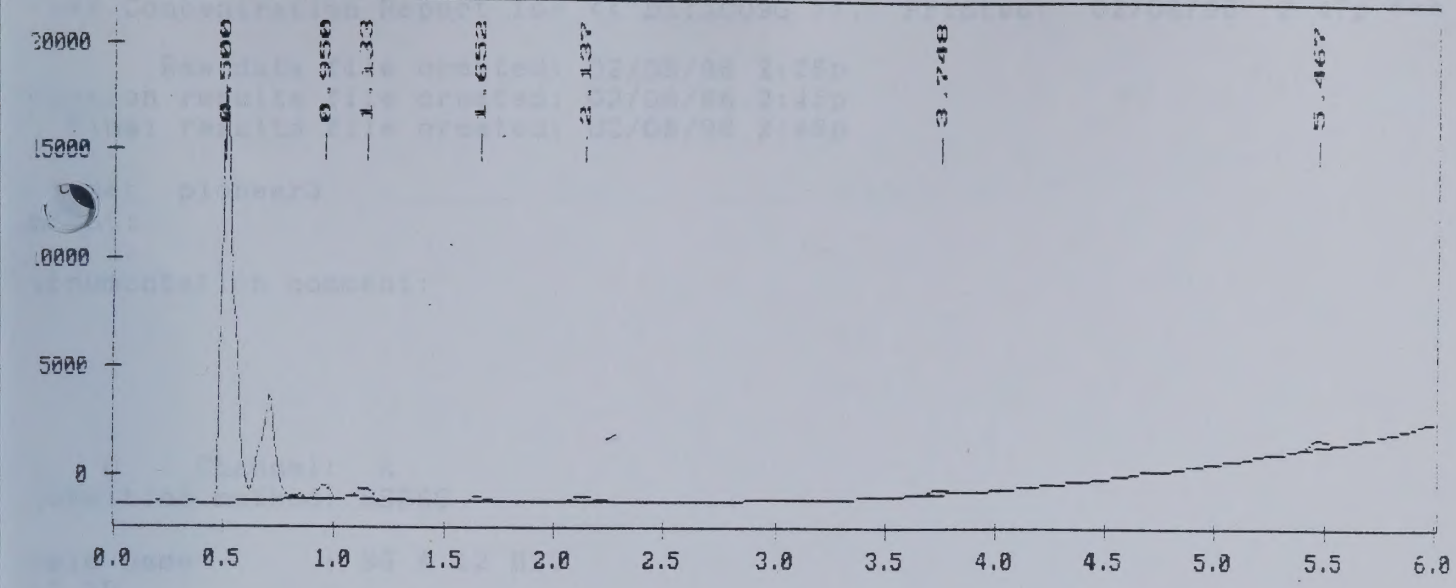
ple name : SG # 11 H20
l ID :
ection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
ution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDH20
egration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
ibration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
o ing section : created 02/05/96 12:58p, modified 02/05/96 10:11p
omatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 6
nber of components entered : 3
ber of components found : 3
ber of components not found: 0
nber of unidentified peaks : 3

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA008G 11:51a 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	1.652	1625.47717	231.124954	354.02630	4.591402	1.816
Cis 1.2-Dichlor	2.137	2452.20849	253.447784	307.17486	7.983103	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	3.748	1612.40014	217.982361	345.85070	4.662127	3.516
Tetrachloroethe	5.467	1893.72558	343.818176	376.65402	5.027759	5.253
		7583.81152	1046.37329		22.264393	

*** Concentration Report for << DATA009G >>, Printed: 02/08/96 2:47p ***

Raw data file created: 02/08/96 2:26p
tection results file created: 02/08/96 2:45p
Final results file created: 02/08/96 2:46p

me: pioneer3
mment:

strumentation comment:

r: 0 Channel: A
quisition method: BSBSG

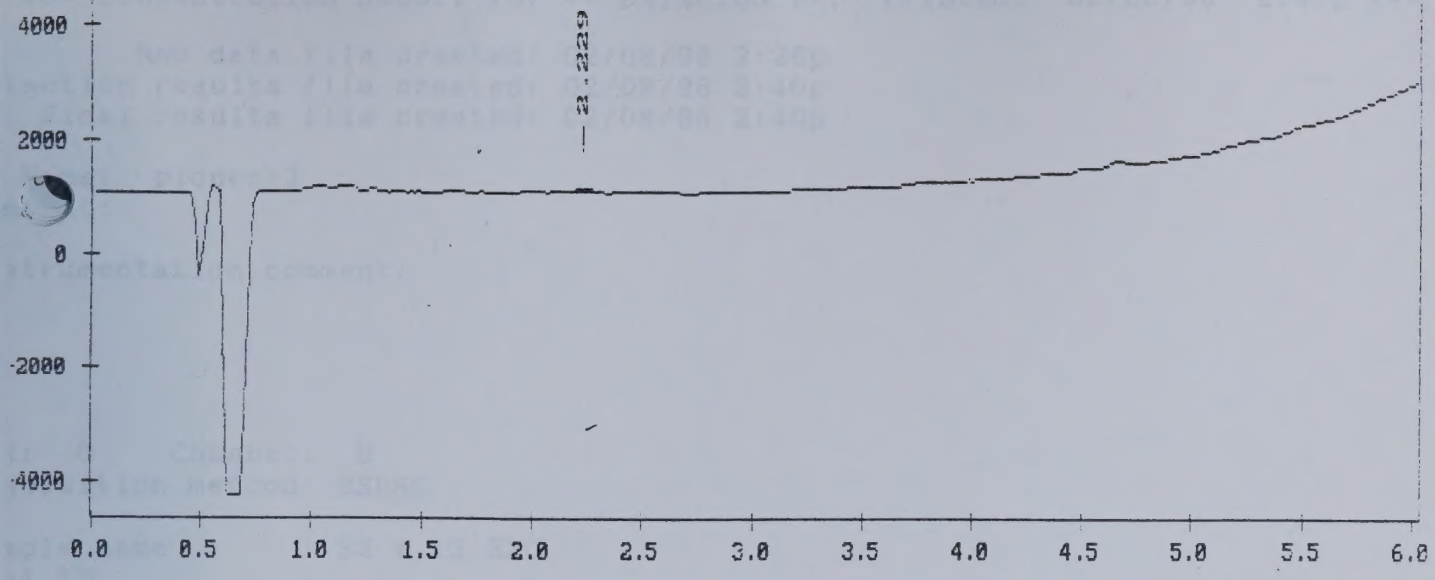
mple name : SG # 12 H2O
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: PIDH20
tegration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
alibration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
eting section : created 02/05/96 12:58p, modified 02/05/96 10:11p
romatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 1
mber of components entered : 3
ber of components found : 1
ber of components not found: 2
ber of unidentified peaks : 0

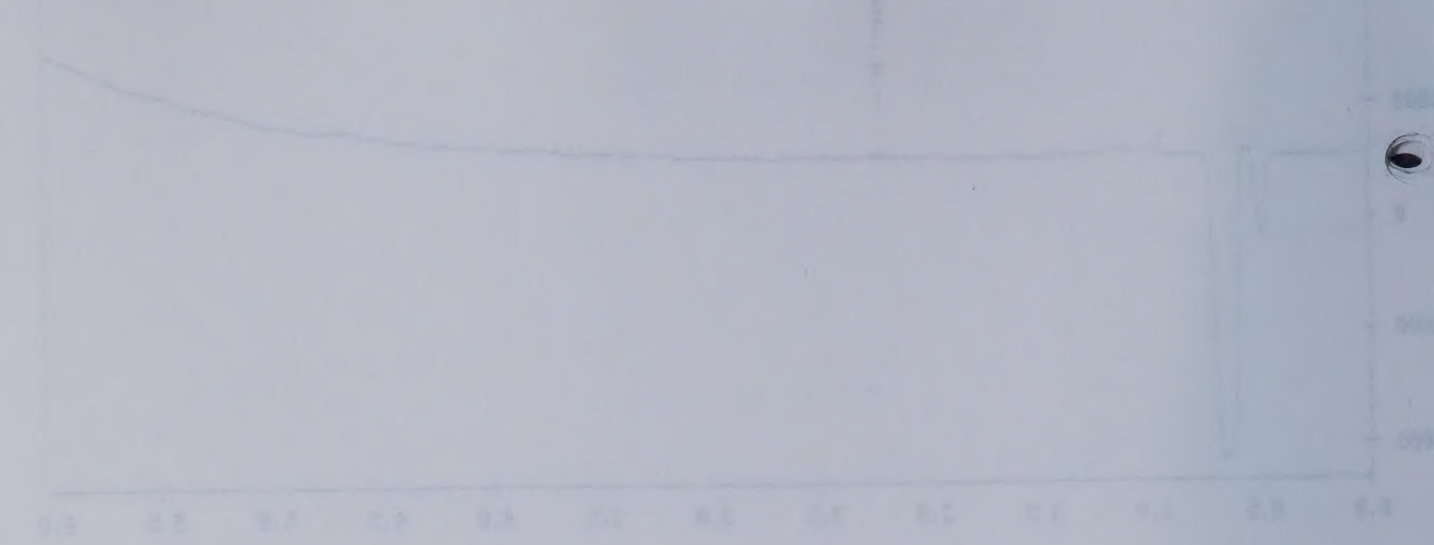
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA009G 2:48p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.229	221.009354	53.217121	533.91748	0.413939	2.222
Trichloroethene	NF	Not Found	Not Found	936.93689	Not Found	3.479
Tetrachloroethe	NF	Not Found	Not Found	848.60638	Not Found	5.212
		221.009354	53.217121		0.413939	



*** Concentration Report for << DATA010G >>, Printed: 02/08/96 2:41p ***

Raw data file created: 02/08/96 2:26p
tection results file created: 02/08/96 2:40p
Final results file created: 02/08/96 2:40p

Name: pioneer3
m. t:

strumentation comment:

: 0 Channel: B
quisition method: BSBSG

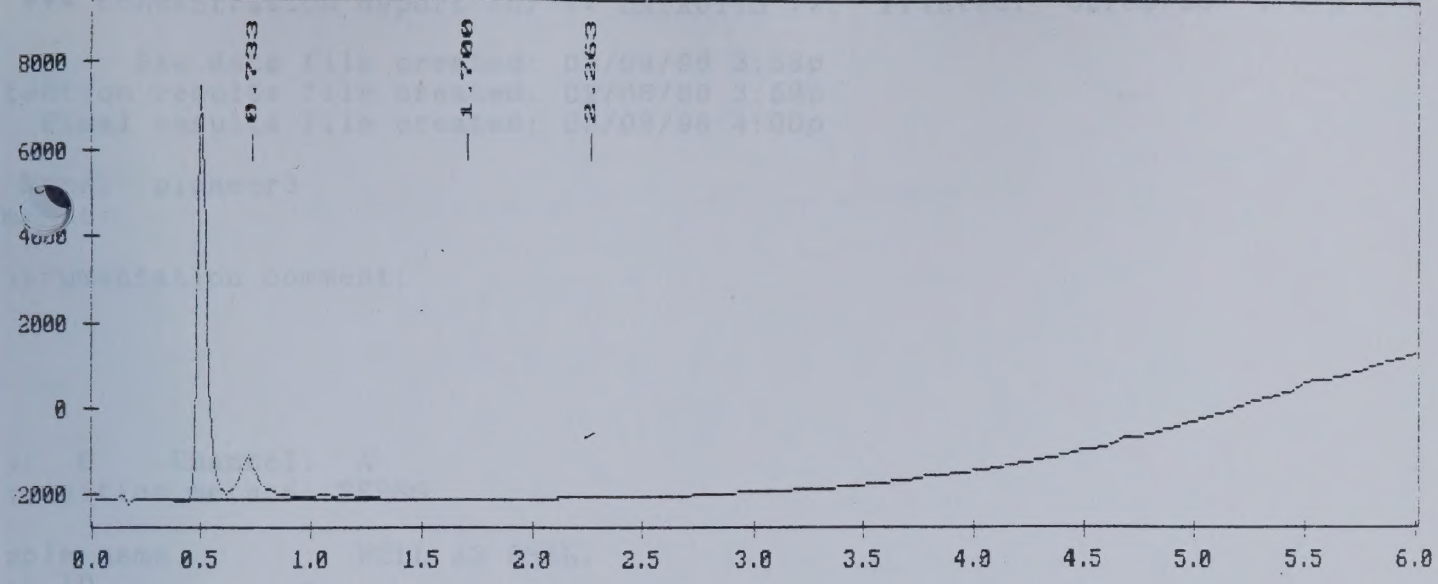
nple name : SG # 12 H2O
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
nple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: FIDH2O
tegration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
libration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
ing section : created 02/05/96 1:08p, modified 02/05/96 10:09p

mber of raw data points : 360
ber of peaks detected : 3
ber of components entered : 5
mber of components found : 2
ber of components not found: 3
ber of unidentified peaks : 1

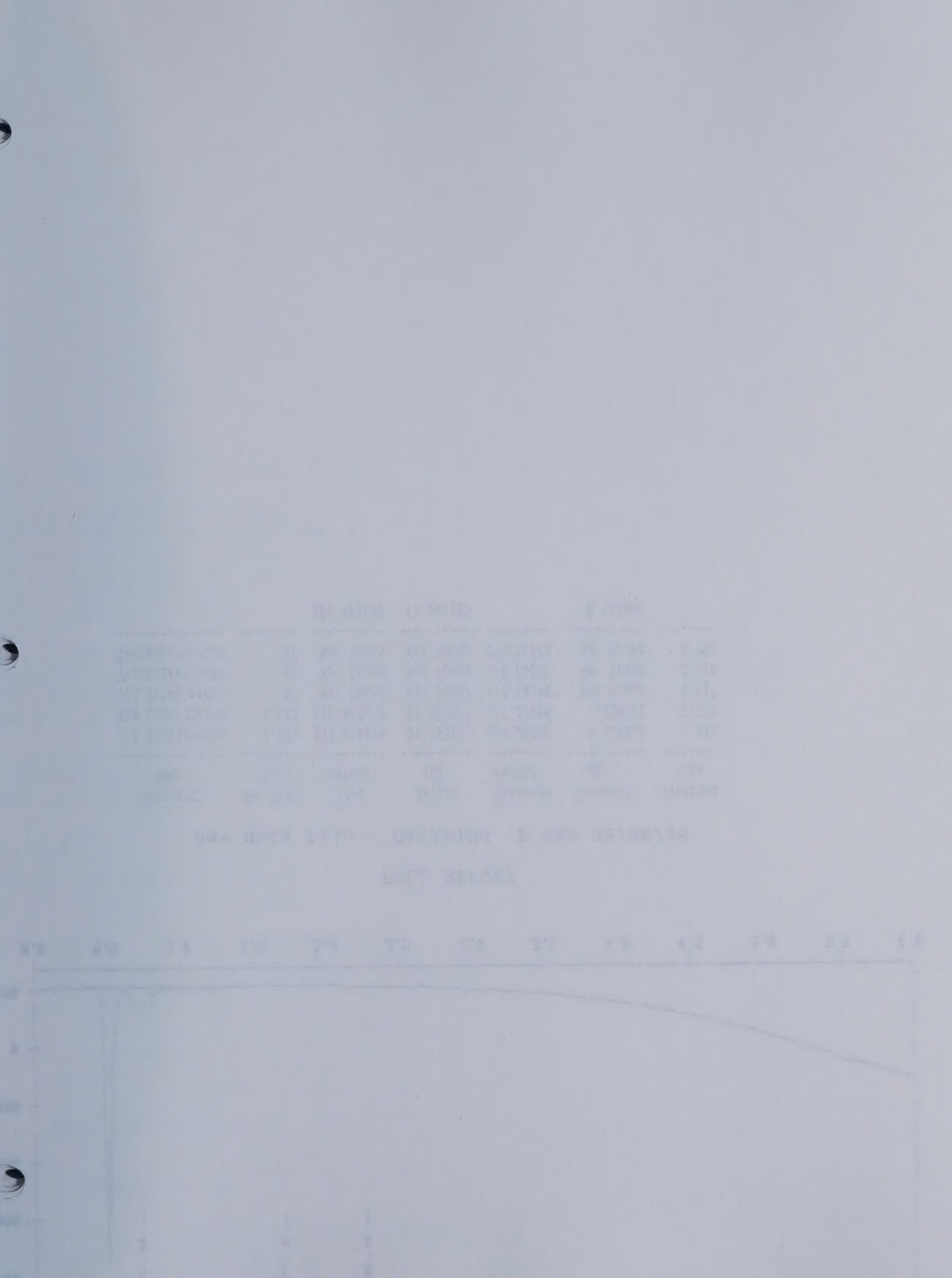
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA010G 2:42p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.700	225.948486	27.325531	354.02630	0.638225	1.816
Cis 1,2-Dichlor	2.263	468.943970	53.915977	307.17486	1.526635	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	NF	Not Found	Not Found	345.85070	Not Found	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		694.892456	81.241562		2.164860	



*** Concentration Report for << DATA011G >>, Printed: 02/08/96 4:01p ***

Raw data file created: 02/08/96 3:58p
tection results file created: 02/08/96 3:59p
Final results file created: 02/08/96 4:00p

Name: pioneer3
m t:

strumentation comment:

: 0 Channel: A
quisition method: BSBSG

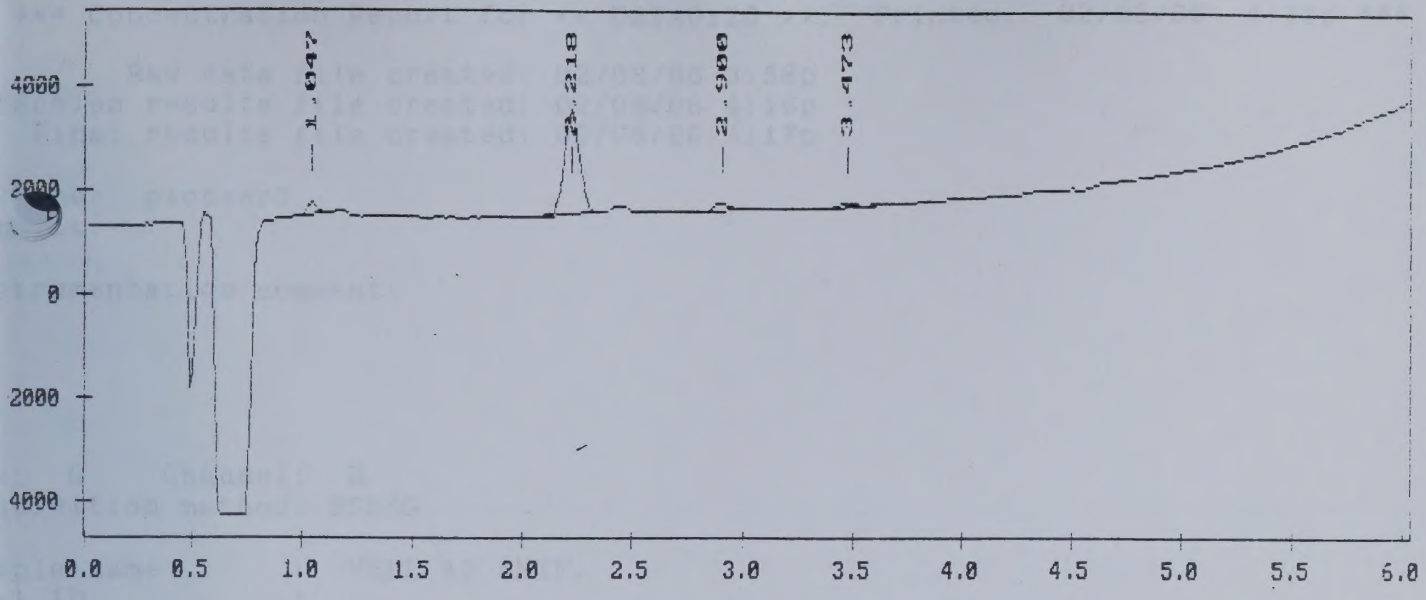
nple name : WELL A3 5MIN.
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
nple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

cessing method: PIDH20
tegration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
ibration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
ing section : created 02/05/96 12:58p, modified 02/05/96 10:11p
romatogram baseline is manually edited

ber of raw data points : 361
ber of peaks detected : 4
mber of components entered : 3
ber of components found : 2
ber of components not found: 1
mber of unidentified peaks : 2

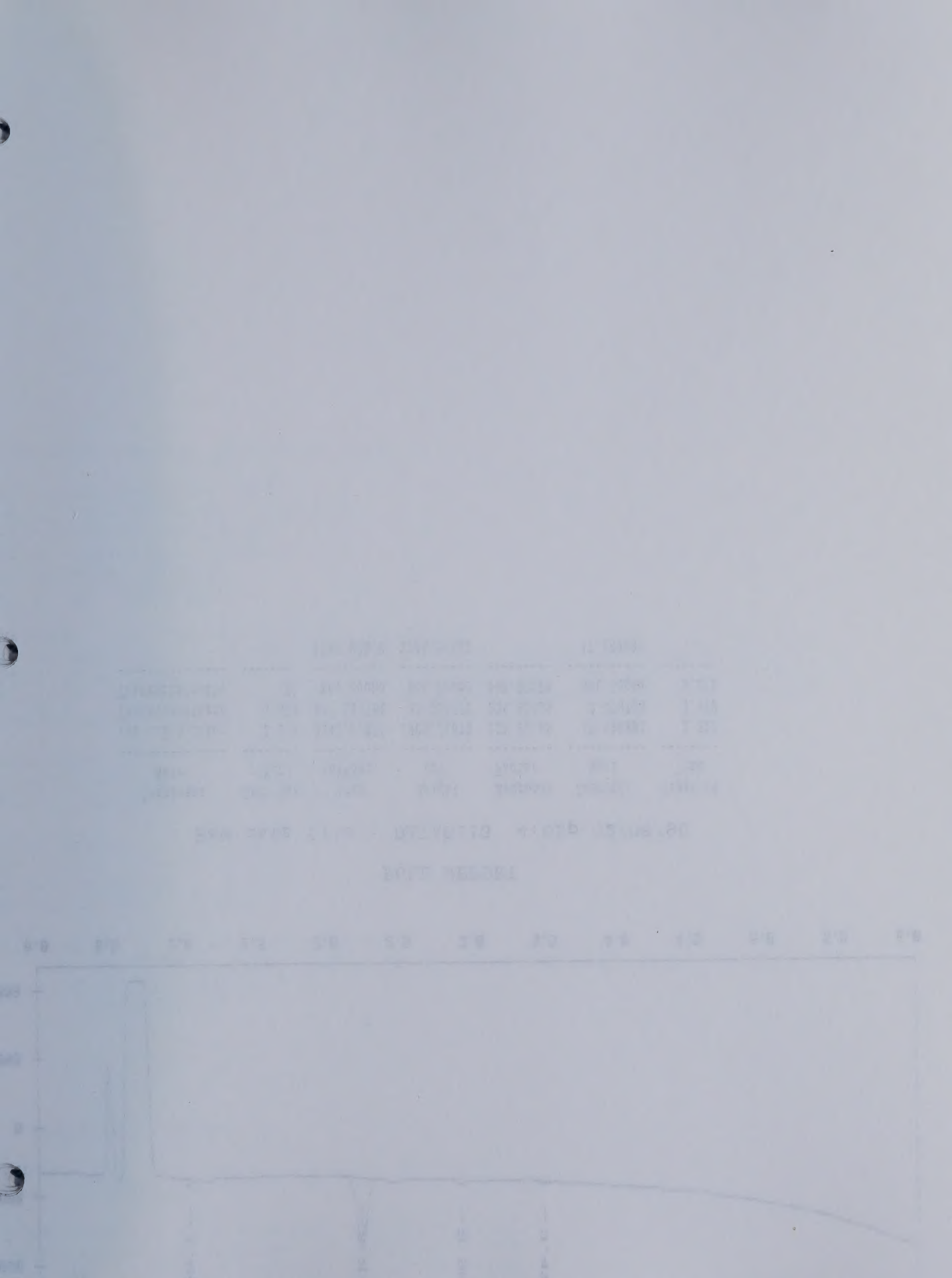
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA011G 4:02p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.218	9343.01855	1965.24572	533.91748	17.498993	2.222
Trichloroethene	3.473	441.020782	83.298698	936.93689	0.470705	3.479
Tetrachloroethe	NF	Not Found	Not Found	848.60638	Not Found	5.212
		9784.03906	2048.54443		17.969698	



*** Concentration Report for << DATA012G >>, Printed: 02/08/96 4:18p ***

Raw data file created: 02/08/96 3:58p
tection results file created: 02/08/96 4:16p
Final results file created: 02/08/96 4:17p

me: pioneer3
nt:

strumentation comment:

: 0   Channel: B
quisition method: BSBSG

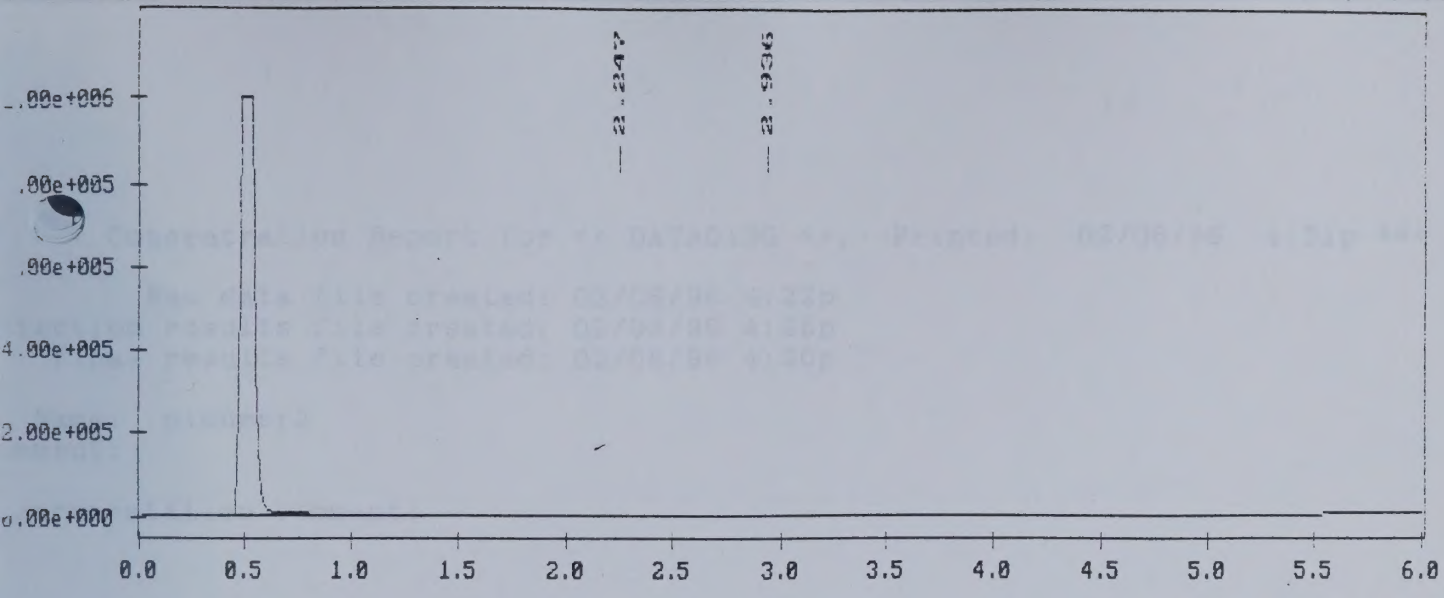
nple name   : WELL A3 5MIN.
al ID   :
jection volume   : 500.0000
amount (Sample): 0.000000
nple amount   : 1.000000
lution factor   : 1.000000

amount (Calib)   : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: FIDH2O
tegration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
libration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
ing section : created 02/05/96 1:08p, modified 02/05/96 10:09p
romatogram baseline is manually edited

ber of raw data points   : 360
ber of peaks detected   : 2
nber of components entered : 5
ber of components found   : 1
ber of components not found: 4
nber of unidentified peaks : 1

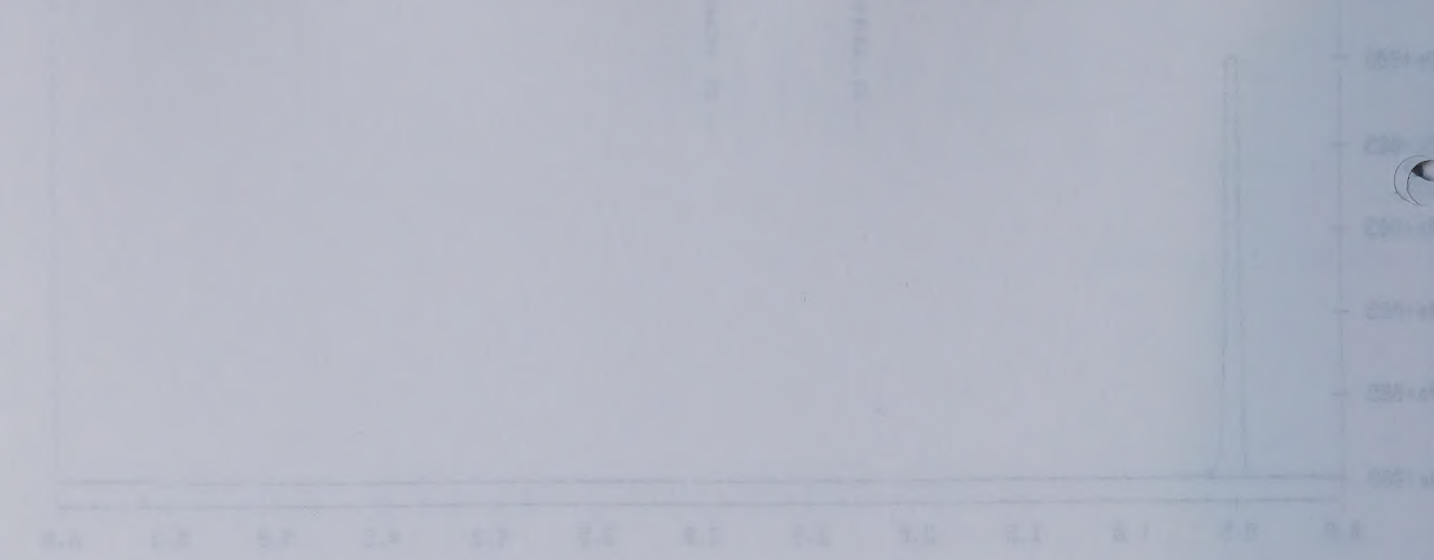
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA012G 4:18p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	NF	Not Found	Not Found	354.02630	Not Found	1.816
Cis 1,2-Dichlor	2.247	6175.41259	1063.72888	307.17486	20.103899	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	NF	Not Found	Not Found	345.85070	Not Found	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		6175.41259	1063.72888		20.103899	



Concentration Report for << DATA013G >>, Printed: 02/08/96 4:31p ***

Raw data file created: 02/08/96 4:22p
tection results file created: 02/08/96 4:28p
Final results file created: 02/08/96 4:30p

Name: pioneer3
mment:

strumentation comment:

t: 0 Channel: A
quisition method: BSBSG

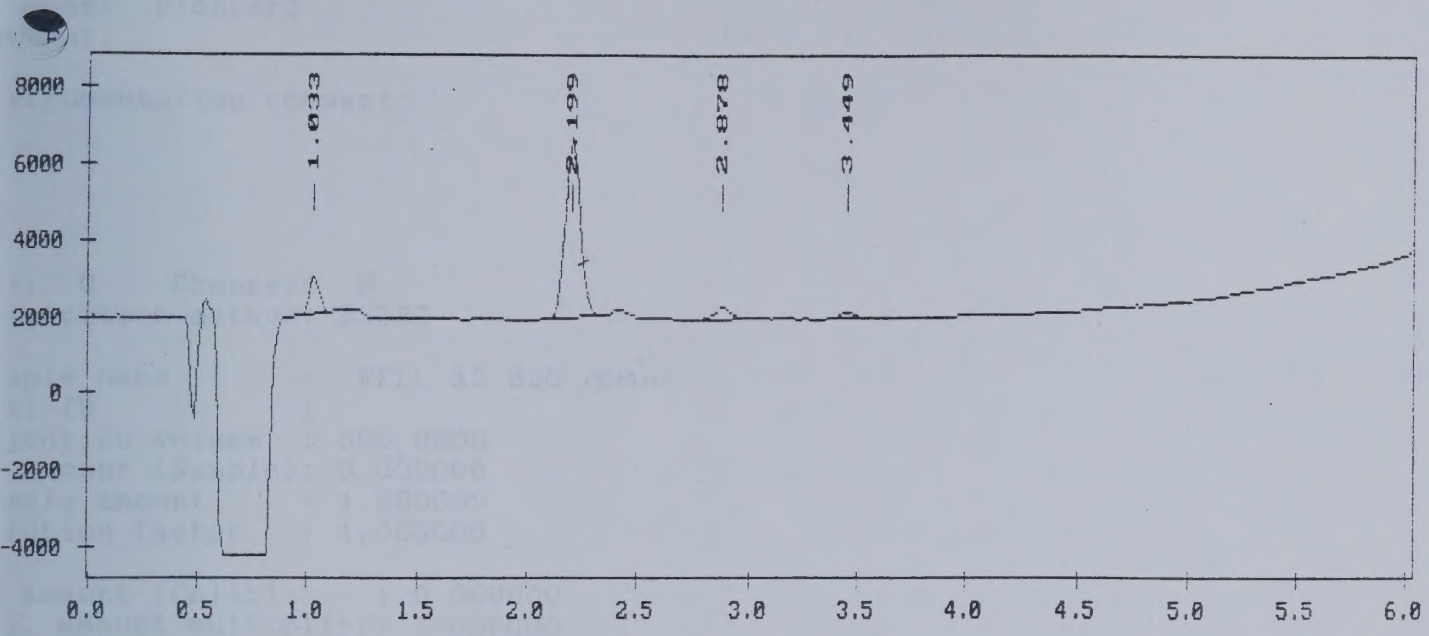
ple name : WELL A3 H20 15min
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

unt (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ocessing method: PIDH20
tegration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
ibration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
orting section : created 02/05/96 12:58p, modified 02/05/96 10:11p
romatogram baseline is manually edited

ber of raw data points : 361
mber of peaks detected : 4
mber of components entered : 3
ber of components found : 2
...ber of components not found: 1
mber of unidentified peaks : 2

erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA013G 4:33p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.199	21844.5429	4626.72168	533.91748	40.913708	2.222
Trichloroethene	3.449	844.030823	152.500000	936.93689	0.900841	3.479
Tetrachloroethe	NF	Not Found	Not Found	848.60638	Not Found	5.212
		22688.5742	4779.22168		41.814548	

*** Concentration Report for << DATA014G >>, Printed: 02/08/96 4:24p ***

Raw data file created: 02/08/96 4:22p
tection results file created: 02/08/96 4:23p
Final results file created: 02/08/96 4:23p

Name: pioneer3
on ent:

strumentation comment:

: 0 Channel: B
quisition method: BSBSG

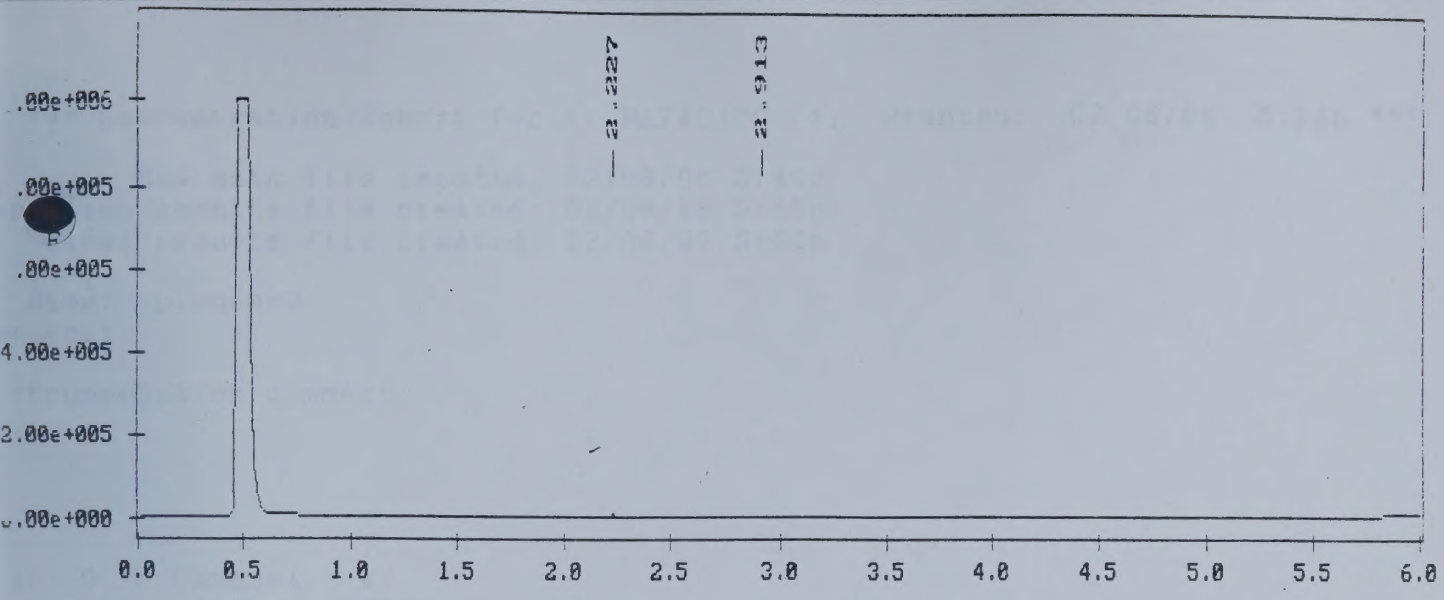
nple name : WELL A3 H20 15min
al ID :
njection volume : 500.0000
S amount (Sample): 0.000000
nple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
ef. response factor : 1.000000

ocessing method: FIDH2O
ntegration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
libration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
ting section : created 02/05/96 1:08p, modified 02/05/96 10:09p

umber of raw data points : 360
ber of peaks detected : 2
ber of components entered : 5
umber of components found : 1
ber of components not found: 4
ber of unidentified peaks : 1

nerior peak labels: Retention Time



FULL REPORT

Raw data file : DATA014G 4:25p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	NF	Not Found	Not Found	354.02630	Not Found	1.816
Cis 1.2-Dichlor	2.227	11861.4726	2427.17334	307.17486	38.614723	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	NF	Not Found	Not Found	345.85070	Not Found	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		11861.4726	2427.17334		38.614723	

*** Concentration Report for << DATA017G >>, Printed: 02/08/96 5:54p ***

Raw data file created: 02/08/96 5:46p
ion results file created: 02/08/96 5:48p
Final results file created: 02/08/96 5:53p

Name: pioneer3
mment:

strumentation comment:

: 0 Channel: A
quisition method: BSBSG

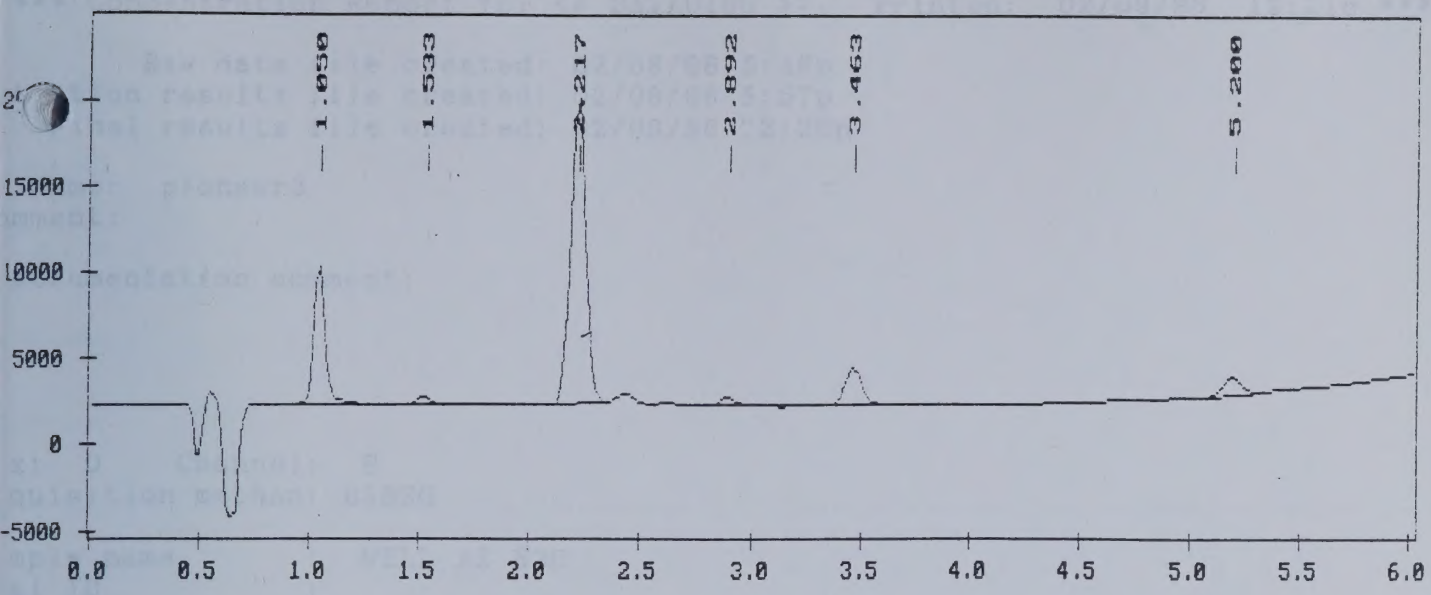
ple name : WELL A2 H2O
l ID :
jection volume : 500.0000
amount (Sample): 0.000000
ple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
. amount multiplier: 1.000000
f. response factor : 1.000000

sing method: PIDH20
tegration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
ibration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
orting section : created 02/05/96 12:58p, modified 02/05/96 10:11p
romatogram baseline is manually edited

ber of raw data points : 361
mber of peaks detected : 6
mber of components entered : 3
ber of components found : 3
ber of components not found: 0
mber of unidentified peaks : 3

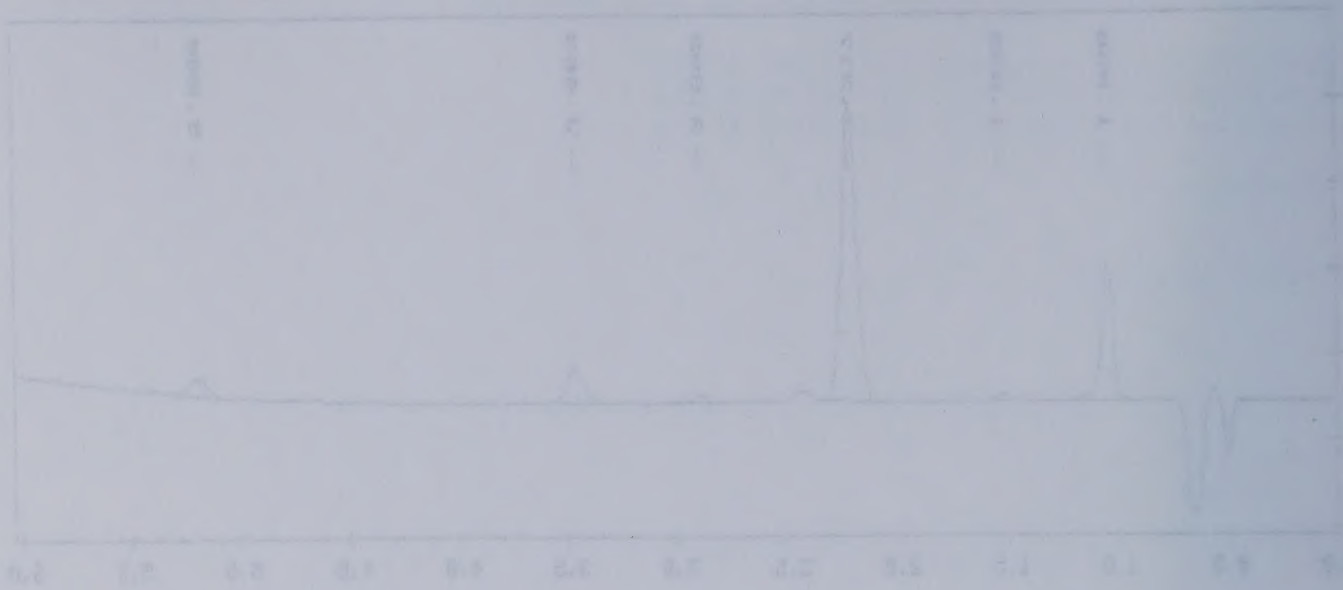
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA017G 5:55p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1.2 Dichlor	2.217	84051.7812	17664.6835	533.91748	157.424667	2.222
Trichloroethene	3.463	11790.7353	2115.66918	936.93689	12.584343	3.479
Tetrachloroethe	5.200	6084.41748	1003.70959	848.60638	7.169894	5.212
		101926.929	20784.0625		177.178894	



*** Concentration Report for << DATA018G >>, Printed: 02/09/96 12:21p ***

Raw data file created: 02/08/96 5:46p
tion results file created: 02/08/96 5:57p
inal results file created: 02/09/96 12:20p

Name: pioneer3
mment:

strumentation comment:

x: 0   Channel: B
quisition method: BSBSG

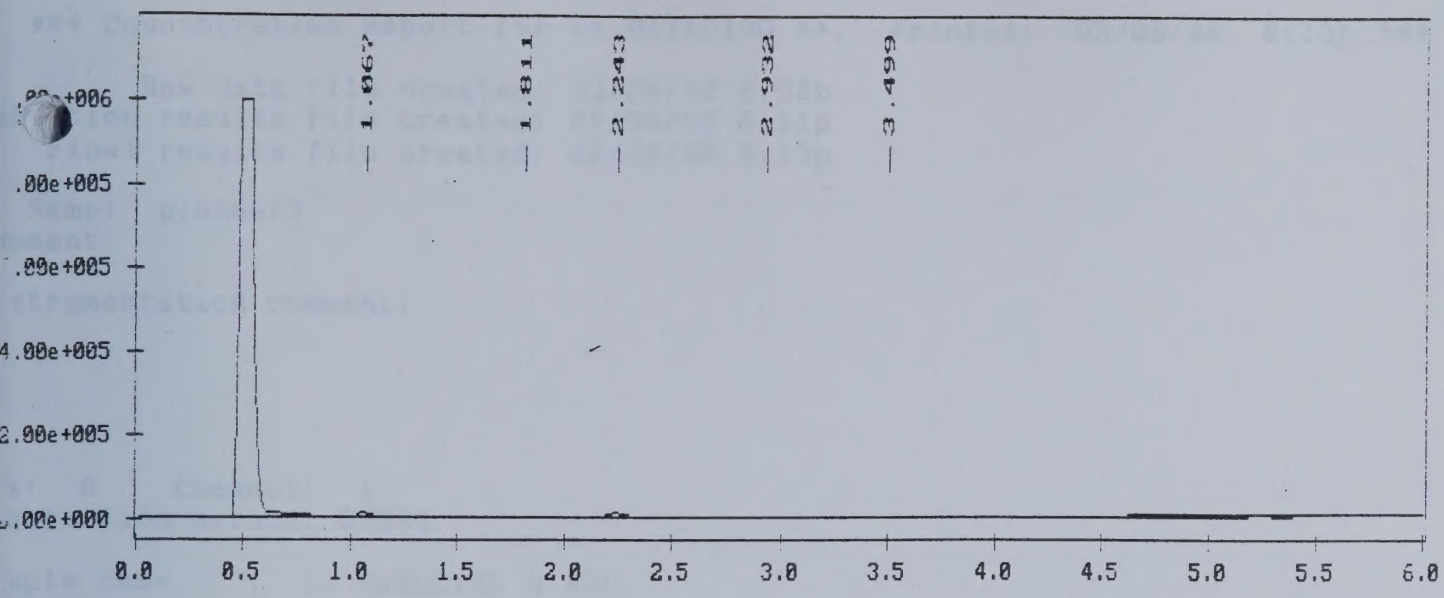
mple name   : WELL A2 H2O
al ID   :
jection volume : 500.0000
amount (Sample): 0.000000
mple amount   : 1.000000
lution factor   : 1.000000

amount (Calib)   : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ssing method: FIDH2O
tegration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
libration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
orting section : created 02/05/96 1:08p, modified 02/05/96 10:09p
romatogram baseline is manually edited

ber of raw data points   : 360
ber of peaks detected   : 5
mber of components entered : 5
nber of components found   : 3
ber of components not found: 2
mber of unidentified peaks : 2

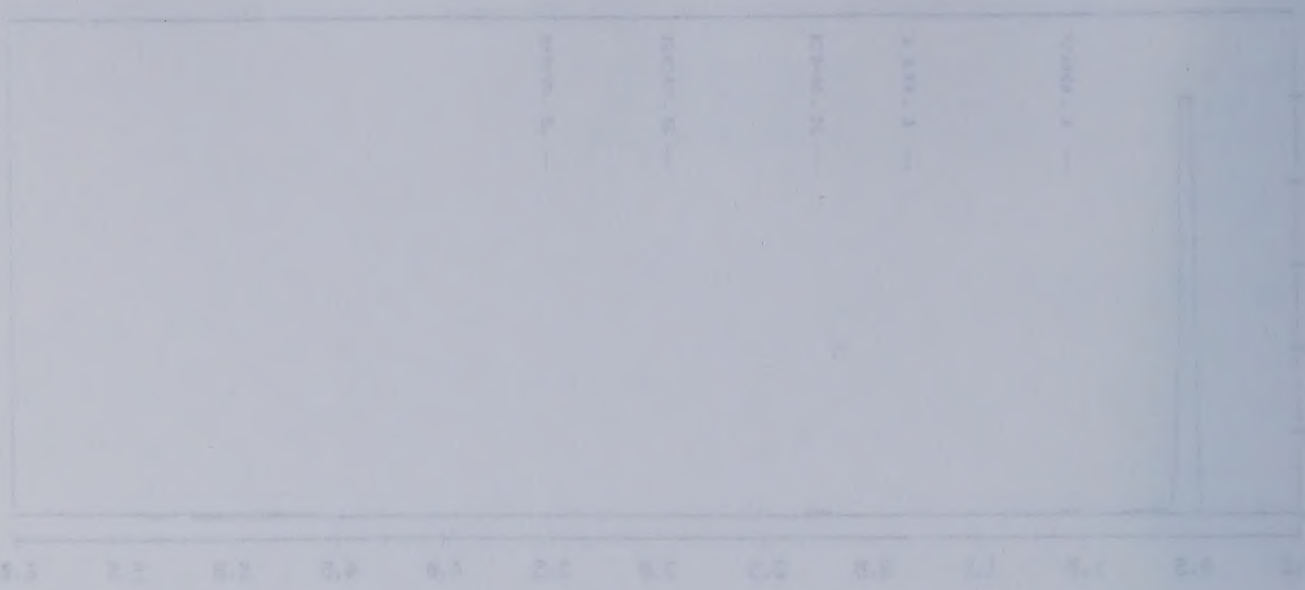
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA018G 12:22p 02/09/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1,1 Dichloroeth	1.811	14739.9853	1473.13427	354.02630	41.635284	1.816
Cis 1,2-Dichlor	2.243	60650.0429	9337.62890	307.17486	197.444687	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	3.499	5453.71875	776.382202	345.85070	15.768997	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		80843.7500	11587.1455		254.848969	



*** Concentration Report for << DATA019G >>, Printed: 02/08/96 6:13p ***

Raw data file created: 02/08/96 6:05p
et tion results file created: 02/08/96 6:11p
Final results file created: 02/08/96 6:13p

Name: pioneer3
omment:

strumentation comment:

x: 0 Channel: A
quisition method: BSBSG

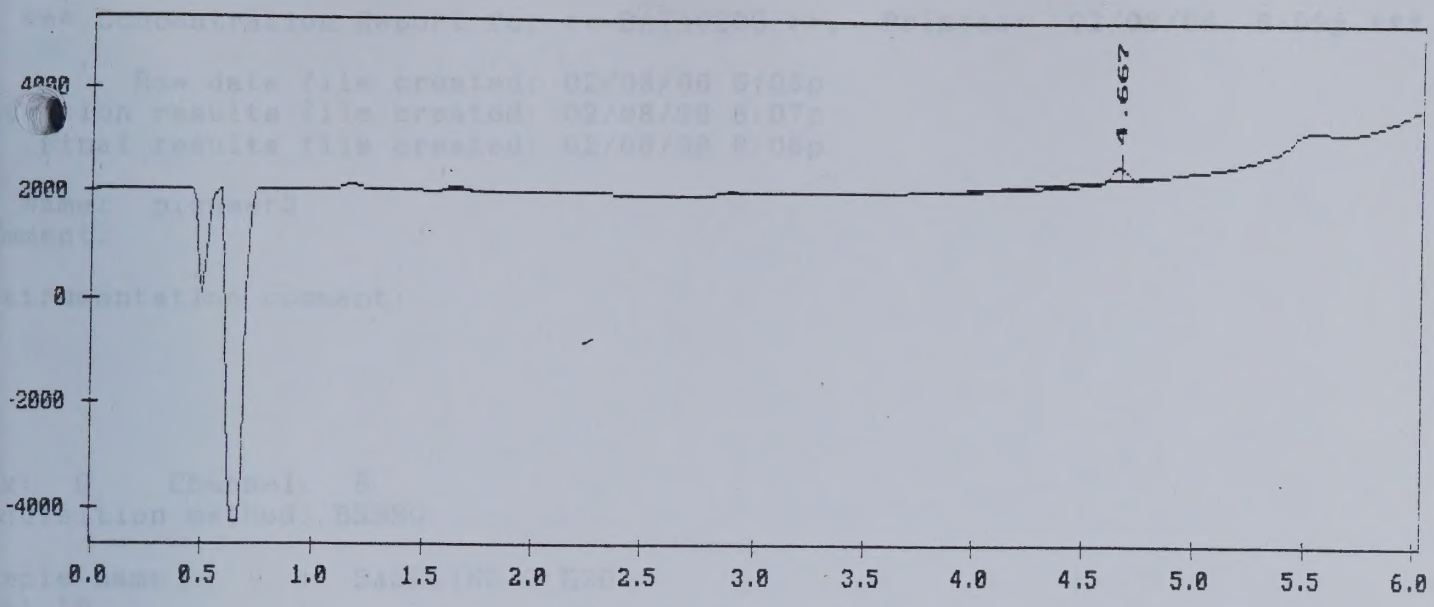
nple name : BASELINE 3 H20
al ID :
jection volume : 500.0000
amount (Sample): 0.000000
nple amount : 1.000000
lution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
f. response factor : 1.000000

ssing method: PIDH20
tegration section: created 02/05/96 12:58p, modified 02/05/96 12:58p
libration section: created 02/05/96 12:58p, modified 02/05/96 9:30p
orting section : created 02/05/96 12:58p, modified 02/05/96 10:11p
romatogram baseline is manually edited

ıber of raw data points : 361
..ıber of peaks detected : 1
mber of components entered : 3
ıber of components found : 0
ıber of components not found: 3
mber of unidentified peaks : 1

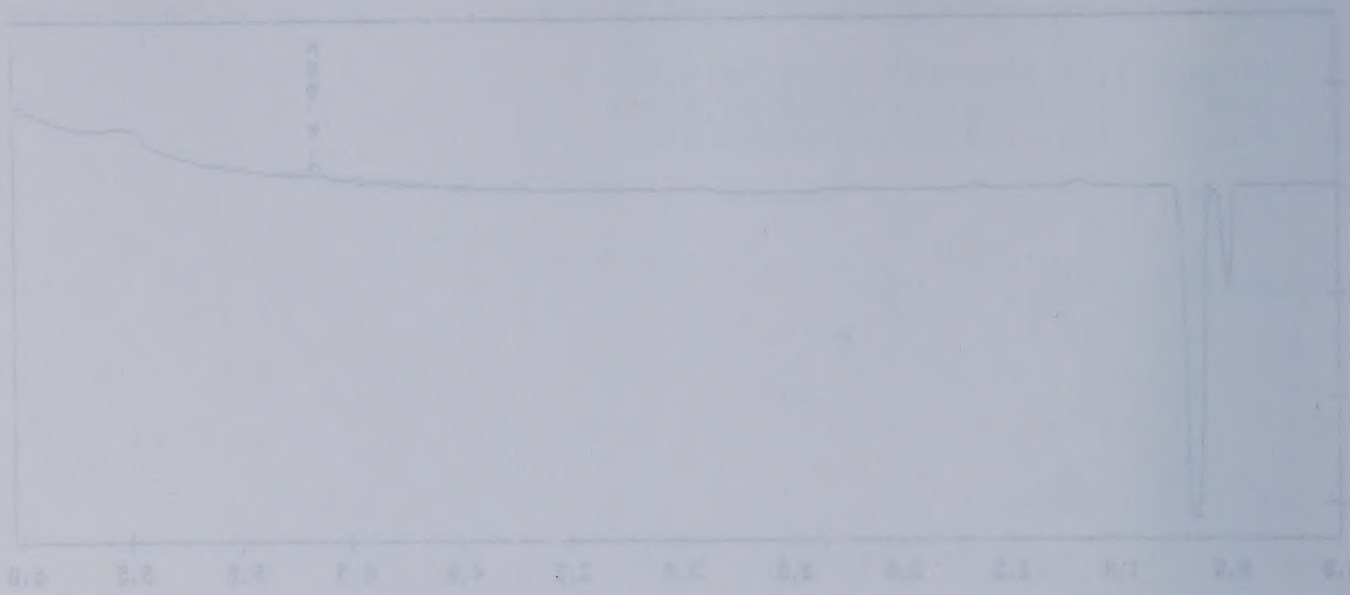
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA019G 6:14p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
Cis 1,2 Dichlor	NF	Not Found	Not Found	533.91748	Not Found	2.222
Trichloroethene	NF	Not Found	Not Found	936.93689	Not Found	3.479
Tetrachloroethe	NF	Not Found	Not Found	848.60638	Not Found	5.212
		0.000000	0.000000		0.000000	



*** Concentration Report for << DATA020G >>, Printed: 02/08/96 6:09p ***

Raw data file created: 02/08/96 6:05p
et[illegible]tion results file created: 02/08/96 6:07p
Final results file created: 02/08/96 6:08p

Name: pioneer3
omment:

strumentation comment:

x: 0 Channel: B
quisition method: BSBSG

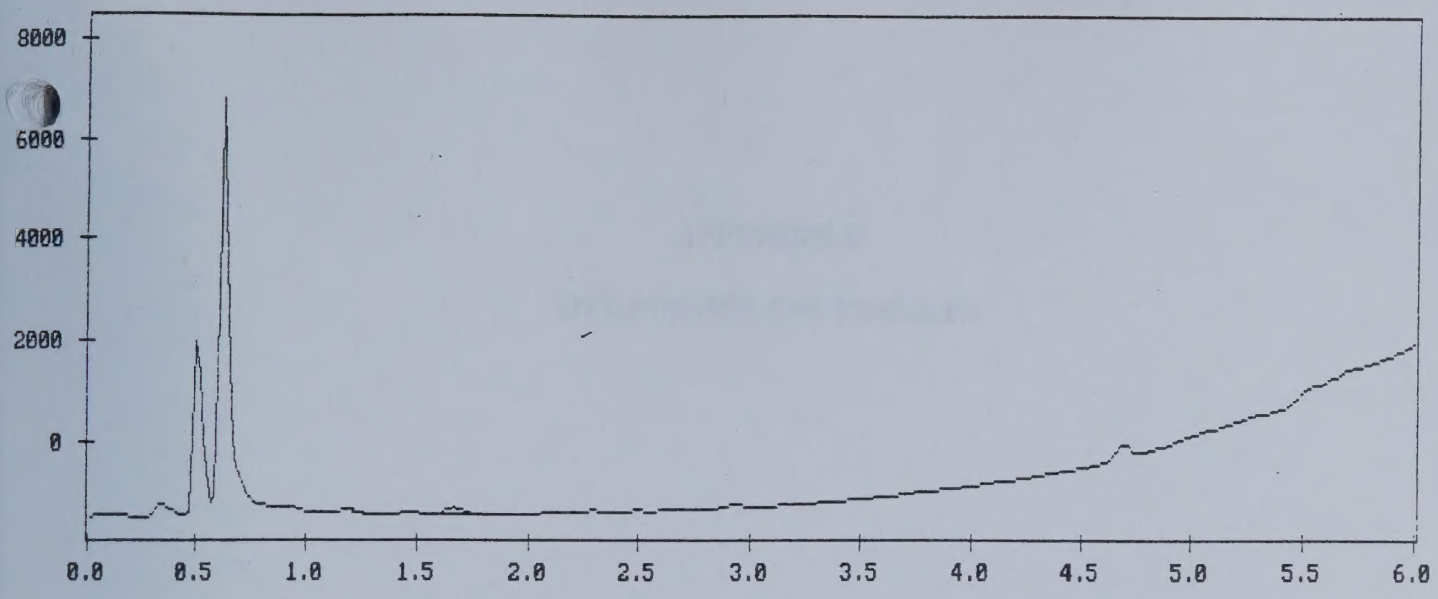
nple name : BASELINE 3 H20
al ID :
njection volume : 500.0000
amount (Sample): 0.000000
nple amount : 1.000000
ilution factor : 1.000000

amount (Calib) : 0.000000
j. amount multiplier: 1.000000
ef. response factor : 1.000000

ssing method: FIDH2O
ntegration section: created 02/05/96 1:08p, modified 02/05/96 2:45p
libration section: created 02/05/96 1:08p, modified 02/05/96 8:45p
orting section : created 02/05/96 1:08p, modified 02/05/96 10:09p
romatogram baseline is manually edited

ber of raw data points : 360
mber of peaks detected : 0
mber of components entered : 5
ber of components found : 0
ber of components not found: 5
mber of unidentified peaks : 0

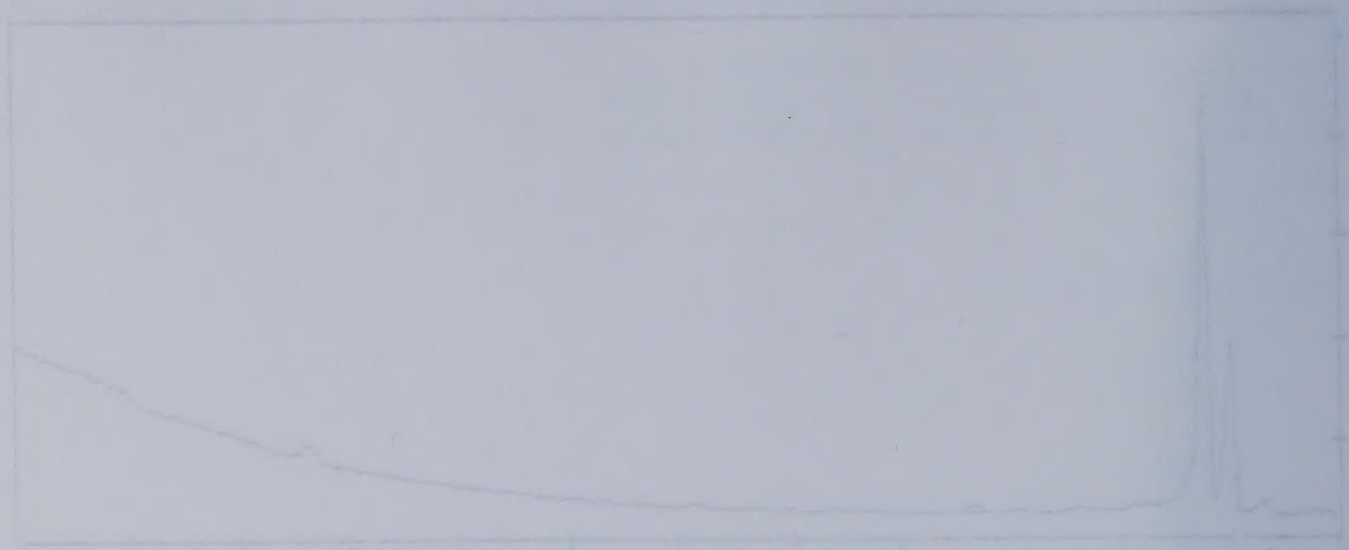
erior peak labels: Retention Time



FULL REPORT

Raw data file : DATA020G 6:10p 02/08/96

Component Name	Ret Time (Min)	Area (uV*Sec)	Height (uV)	Response Factor	Concentr. ug/l	Expected Time
1.1 Dichloroeth	NF	Not Found	Not Found	354.02630	Not Found	1.816
Cis 1.2-Dichlor	NF	Not Found	Not Found	307.17486	Not Found	2.252
111 Trichloroet	NF	Not Found	Not Found	419.49096	Not Found	2.637
Trichloroethene	NF	Not Found	Not Found	345.85070	Not Found	3.516
Tetrachloroethe	NF	Not Found	Not Found	376.65402	Not Found	5.253
		0.000000	0.000000		0.000000	



APPENDIX D

HELP MODELING RESULTS

BUTTE CORRECTIVE MEASURES ASSESSMENT					
SUMMARY OF HELP MODELLING RESULTS					
DESCRIPTION	**AREA (acres)**	**LEACHATE GENERATION (in/year)**	**LEACHATE GENERATION (cu ft/yr)**	**INPUT FILE NAME**	**ET FILE NAME**
BASELINE (PRECLOSURE) CONDITIONS					
A and G, Areas w/ adequate cover soil but poorily graded and with poor vegetation. LAI=1.	28.2	1.05	107818	cma-prea	butte1
B, Area west of strand fence on west portion of landfill. Area was closed and revegetated prior to permitting as solid waste unit. LAI=1.	6.6	0.885	21193	cma-preb	butte1
C, Area immediately west of most recently active area. Average ex. cover depth = 12 inches. LAI=1.	7.7	1.07	29953	cma-prec	butte1
D: East of entrance road, includes the most recently active area. No significant cover in place beyond interim cover. Very sparse vegetation. LAI=0.	10	0.978	35483	cma-pred	butte2
E: Southern portion of landfill that requires additional cover. Average cover depth = 12 inches. Poor vegetation. LAI=1.	3.6	1.07	14034	cma-pree	butte1
F: Area of landfill south of Clark Tailings requiring additional cover. Average cover depth = 6 inches. LAI=1.	5.9	0.889	19029	cma-pref	butte1
LANDFILL TOTAL			**227510**		
Clark Tailings, Existing Conditions, poor grading on top, poor vegetative cover, average cover depth = 6 inches. LAI=1.	60	1.24	**269622**	clk-ex	butte1
ALTERNATIVE 3					
Landfill, Area B, area west of fence on west of landfill. Area closed prior to permitting.	6.6	0.885	21193	cma-preb	butte1
Landfill, pre-1991 area	51.4	0.492	91775	alt3-a	butte3
Landfill, post-1991 area	4	0.637	9245	alt3-d	butte3
LANDFILL TOTAL			**122213**		
Clark Tailings	52	0.536	101264	alt3-clk	butte3
ALTERNATIVE 5					
LANDFILL TOTAL (same as Alternative 3)	62		122213		
Clark Tailings	52	0.581	109648	alt5-clk	butte3
ALTERNATIVE 6					
Landfill	62	0.189	42580	alt6-lf	butte3
Clark Tailings	52	0.133	25031	alt6-clk	butte3

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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                    USAE WATERWAYS EXPERIMENT STATION             **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
**                                                                  **
**                                                                  **
**********************************************************************
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\CMA-PREA.D10
OUTPUT DATA FILE:           C:\HELP3\CMA-PREA.OUT


TIME:  11:25     DATE:  12/10/1996


**********************************************************************

     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Areas A and G

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
          THICKNESS                     =    24.00   INCHES
          POROSITY                      =     0.4370 VOL/VOL
          FIELD CAPACITY                =     0.1050 VOL/VOL
          WILTING POINT                 =     0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT    =     0.1061 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =   180.00   INCHES
          POROSITY                      =     0.6710 VOL/VOL
          FIELD CAPACITY                =     0.2920 VOL/VOL
          WILTING POINT                 =     0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =     0.2456 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 500. FEET.

SCS RUNOFF CURVE NUMBER	=	73.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	28.200	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.431	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.496	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	46.754	INCHES
TOTAL INITIAL WATER	=	46.754	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.024	0.017	0.066	0.078	0.071	0.004
	0.000	0.000	0.000	0.000	0.004	0.006
STD. DEVIATIONS	0.100	0.053	0.123	0.116	0.245	0.031
	0.000	0.002	0.000	0.000	0.017	0.018
EVAPOTRANSPIRATION						
TOTALS	0.482	0.482	0.666	0.786	1.756	2.241
	1.465	1.251	1.209	0.667	0.535	0.466
STD. DEVIATIONS	0.147	0.224	0.241	0.392	0.721	0.917
	0.775	0.614	0.716	0.408	0.237	0.151
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0908	0.0846	0.0985	0.0971	0.1002	0.0996
	0.1081	0.0998	0.0724	0.0632	0.0622	0.0766
STD. DEVIATIONS	0.0494	0.0411	0.0372	0.0299	0.0280	0.0279
	0.0280	0.0268	0.0328	0.0441	0.0469	0.0464

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	1359441.2	100.00
RUNOFF	0.271 (0.3238)	27699.46	2.038
EVAPOTRANSPIRATION	12.006 (1.9898)	1228997.75	90.405
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	1.05326 (0.34120)	107818.453	7.93109
CHANGE IN WATER STORAGE	-0.050 (0.8393)	-5075.01	-0.373

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	198590.047
RUNOFF	1.414	144778.0780
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.013346	1366.16455
SNOW WATER	1.81	185283.5620

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3673

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0278

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****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	3.2304	0.1346
2	38.5656	0.2143
SNOW WATER	0.000	

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**          HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**           HELP MODEL VERSION 3.01   (14 OCTOBER 1994)            **
**             DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**               USAE WATERWAYS EXPERIMENT STATION                  **
**          FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\cma-preb.D10
OUTPUT DATA FILE:           C:\HELP3\cma-preb.OUT


TIME:  17:14     DATE:  12/ 9/1996

**********************************************************************

     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Area B

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0873 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    180.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2443 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	74.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	6.600	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.668	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.964	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.436	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	44.489	INCHES
TOTAL INITIAL WATER	=	44.489	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.024	0.017	0.064	0.079	0.071	0.004
	0.000	0.000	0.000	0.000	0.004	0.006
STD. DEVIATIONS	0.101	0.052	0.117	0.121	0.247	0.033
	0.000	0.002	0.000	0.000	0.017	0.018
EVAPOTRANSPIRATION						
TOTALS	0.482	0.489	0.670	0.795	1.764	2.308
	1.510	1.261	1.234	0.688	0.529	0.467
STD. DEVIATIONS	0.146	0.220	0.250	0.389	0.725	0.911
	0.783	0.612	0.725	0.420	0.229	0.148
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0833	0.0738	0.0799	0.0759	0.0815	0.0911
	0.0754	0.0453	0.0515	0.0743	0.0772	0.0753
STD. DEVIATIONS	0.0366	0.0303	0.0317	0.0288	0.0289	0.0280
	0.0311	0.0391	0.0423	0.0342	0.0311	0.0273

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	318167.1	100.00
RUNOFF	0.270 (0.3260)	6471.31	2.034
EVAPOTRANSPIRATION	12.198 (2.0166)	292237.37	91.850
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.88458 (0.33002)	21192.762	6.66089
CHANGE IN WATER STORAGE	-0.072 (0.8090)	-1734.47	-0.545

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	46478.520
RUNOFF	1.406	33675.2383
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.016682	399.66913
SNOW WATER	1.81	43364.2383

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3868

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0248

****

****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.6146	0.1024
2	36.6352	0.2035
SNOW WATER	0.000	

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**                                                                  **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************

PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\cma-prec.D10
OUTPUT DATA FILE:           C:\HELP3\cma-prec.OUT


TIME:  17:30     DATE:  12/ 9/1996


**********************************************************************

     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Area C

**********************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0843 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    180.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2468 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 150. FEET.

SCS RUNOFF CURVE NUMBER	=	75.50	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	7.700	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.431	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.496	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	45.439	INCHES
TOTAL INITIAL WATER	=	45.439	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.024	0.017	0.066	0.078	0.072	0.004
	0.000	0.000	0.000	0.000	0.004	0.006
STD. DEVIATIONS	0.100	0.053	0.123	0.116	0.245	0.032
	0.000	0.002	0.000	0.000	0.017	0.018
EVAPOTRANSPIRATION						
TOTALS	0.484	0.481	0.668	0.780	1.743	2.238
	1.475	1.238	1.216	0.675	0.529	0.465
STD. DEVIATIONS	0.147	0.219	0.239	0.395	0.720	0.918
	0.771	0.606	0.704	0.416	0.236	0.149
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0990	0.0931	0.1016	0.0961	0.1000	0.1079
	0.1049	0.0687	0.0470	0.0687	0.0878	0.0967
STD. DEVIATIONS	0.0440	0.0317	0.0327	0.0299	0.0300	0.0325
	0.0312	0.0373	0.0481	0.0547	0.0414	0.0381

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	371194.9	100.00
RUNOFF	0.273 (0.3260)	7618.49	2.052
EVAPOTRANSPIRATION	11.992 (1.9891)	335185.06	90.299
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	1.07162 (0.34460)	29952.979	8.06934
CHANGE IN WATER STORAGE	-0.056 (0.8172)	-1561.65	-0.421

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	54224.941
RUNOFF	1.417	39595.9180
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.014842	414.84467
SNOW WATER	1.81	50591.6133

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3640
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0279

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.5452	0.1288
2	38.3067	0.2128
SNOW WATER	0.000	

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**                                                                           **
**                                                                           **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)                   **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                  USAE WATERWAYS EXPERIMENT STATION                        **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                           **
**                                                                           **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE2.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\CMA-PRED.D10
OUTPUT DATA FILE:           C:\HELP3\cma-pred.OUT


TIME:  10: 2     DATE:  12/10/1996

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     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Area D

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0486 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    180.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2449 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 250. FEET.

SCS RUNOFF CURVE NUMBER	=	81.60	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	10.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.435	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.964	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.436	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	44.372	INCHES
TOTAL INITIAL WATER	=	44.372	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.056	0.053	0.167	0.230	0.134	0.011
	0.001	0.001	0.001	0.000	0.020	0.033
STD. DEVIATIONS	0.148	0.110	0.230	0.252	0.360	0.058
	0.006	0.006	0.007	0.000	0.064	0.060
EVAPOTRANSPIRATION						
TOTALS	0.482	0.468	0.574	0.607	1.743	2.235
	1.352	1.174	1.168	0.808	0.577	0.477
STD. DEVIATIONS	0.147	0.215	0.202	0.317	0.744	0.948
	0.783	0.619	0.670	0.408	0.248	0.154
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0909	0.0823	0.0892	0.0845	0.0917	0.0959
	0.0780	0.0598	0.0638	0.0839	0.0768	0.0808
STD. DEVIATIONS	0.0410	0.0322	0.0339	0.0308	0.0329	0.0290
	0.0362	0.0415	0.0477	0.0378	0.0379	0.0344

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	482071.4	100.00
RUNOFF	0.706 (0.5483)	25642.67	5.319
EVAPOTRANSPIRATION	11.664 (1.9794)	423390.66	87.827
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.97749 (0.35717)	35483.016	7.36053
CHANGE IN WATER STORAGE	-0.067 (0.7247)	-2444.96	-0.507

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	70422.000
RUNOFF	1.530	55549.1641
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.016694	606.00531
SNOW WATER	1.81	65703.3906

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3583

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0405

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.7413	0.1235
2	36.8949	0.2050
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE            **
**               HELP MODEL VERSION 3.01   (14 OCTOBER 1994)            **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                **
**                   USAE WATERWAYS EXPERIMENT STATION                  **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                      **
**                                                                      **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\cma-pree.D10
OUTPUT DATA FILE:           C:\HELP3\cma-pree.OUT


TIME:  10:10     DATE:  12/10/1996


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     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Area E

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.1050 VOL/VOL
          WILTING POINT                =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0843 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    180.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2468 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 250. FEET.

SCS RUNOFF CURVE NUMBER	=	74.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	3.600	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.431	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.496	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	45.439	INCHES
TOTAL INITIAL WATER	=	45.439	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.024	0.017	0.066	0.078	0.072	0.005
	0.000	0.000	0.000	0.000	0.004	0.006
STD. DEVIATIONS	0.099	0.053	0.123	0.116	0.251	0.039
	0.000	0.002	0.000	0.000	0.017	0.018
EVAPOTRANSPIRATION						
TOTALS	0.484	0.480	0.671	0.781	1.740	2.240
	1.482	1.232	1.217	0.665	0.535	0.467
STD. DEVIATIONS	0.145	0.223	0.240	0.387	0.717	0.909
	0.770	0.604	0.710	0.406	0.238	0.150
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0988	0.0931	0.1018	0.0963	0.1002	0.1085
	0.1047	0.0676	0.0479	0.0695	0.0885	0.0969
STD. DEVIATIONS	0.0444	0.0319	0.0329	0.0300	0.0302	0.0330
	0.0313	0.0372	0.0484	0.0544	0.0417	0.0384

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.28	(2.345)	173545.7	100.00
RUNOFF	0.273	(0.3279)	3569.27	2.057
EVAPOTRANSPIRATION	11.992	(1.9870)	156706.95	90.297
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	1.07390	(0.34652)	14033.723	8.08647
CHANGE IN WATER STORAGE	-0.058	(0.8125)	-764.35	-0.440

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	25351.920
RUNOFF	1.416	18510.2988
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.014842	193.95335
SNOW WATER	1.81	23653.2207

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3639
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0270

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.2510	0.1042
2	38.3390	0.2130
SNOW WATER	0.000	

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**                                                                  **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY              **
**                 USAE WATERWAYS EXPERIMENT STATION                **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY        **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\cma-pref.D10
OUTPUT DATA FILE:           C:\HELP3\cma-pref.OUT

TIME:  10:22     DATE:  12/10/1996

**********************************************************************

     TITLE:  BUTTE LANDFILL PRECLOSURE CONDITIONS:  Area F

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4370 VOL/VOL
          FIELD CAPACITY                =      0.1050 VOL/VOL
          WILTING POINT                 =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.0873 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =    180.00   INCHES
          POROSITY                      =      0.6710 VOL/VOL
          FIELD CAPACITY                =      0.2920 VOL/VOL
          WILTING POINT                 =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.2443 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 500. FEET.

SCS RUNOFF CURVE NUMBER	=	73.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	5.900	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.668	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.964	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.436	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	44.489	INCHES
TOTAL INITIAL WATER	=	44.489	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.024	0.017	0.064	0.079	0.072	0.003
	0.000	0.000	0.000	0.000	0.004	0.006
STD. DEVIATIONS	0.101	0.052	0.117	0.119	0.251	0.031
	0.000	0.002	0.000	0.000	0.017	0.018
EVAPOTRANSPIRATION						
TOTALS	0.483	0.488	0.674	0.793	1.765	2.309
	1.499	1.263	1.236	0.688	0.529	0.467
STD. DEVIATIONS	0.146	0.218	0.252	0.389	0.716	0.912
	0.777	0.613	0.725	0.422	0.230	0.149
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0838	0.0740	0.0803	0.0762	0.0817	0.0915
	0.0761	0.0450	0.0526	0.0742	0.0772	0.0758
STD. DEVIATIONS	0.0368	0.0304	0.0318	0.0289	0.0290	0.0281
	0.0307	0.0395	0.0428	0.0347	0.0315	0.0275

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	284422.1	100.00
RUNOFF	0.270 (0.3275)	5772.86	2.030
EVAPOTRANSPIRATION	12.194 (2.0186)	261159.36	91.821
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.88852 (0.33178)	19029.482	6.69058
CHANGE IN WATER STORAGE	-0.072 (0.8064)	-1539.63	-0.541

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	41548.980
RUNOFF	1.405	30095.3301
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.016682	357.27997
SNOW WATER	1.81	38765.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3882

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0242

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.6346	0.1058
2	36.6660	0.2037
SNOW WATER	0.000	

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**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY              **
**                 USAE WATERWAYS EXPERIMENT STATION                **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY        **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE1.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\clk-ex.D10
OUTPUT DATA FILE:           C:\HELP3\clk-ex.OUT

TIME:  10:45     DATE:  12/10/1996

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     TITLE:  Clark Tailings, Existing Conditions

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
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                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   4
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4370 VOL/VOL
          FIELD CAPACITY                =      0.1050 VOL/VOL
          WILTING POINT                 =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.0776 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.170000002000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.80
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  22
          THICKNESS                     =    240.00   INCHES
          POROSITY                      =      0.4190 VOL/VOL
          FIELD CAPACITY                =      0.3070 VOL/VOL
          WILTING POINT                 =      0.1800 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.3026 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.189999992000E-04 CM/SEC
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 4 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 800. FEET.

SCS RUNOFF CURVE NUMBER	=	72.70	
FRACTION OF AREA ALLOWING RUNOFF	=	60.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	60.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.786	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.460	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.642	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	73.083	INCHES
TOTAL INITIAL WATER	=	73.083	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	1.00
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.014	0.010	0.039	0.047	0.043	0.000
	0.000	0.000	0.000	0.000	0.002	0.003
STD. DEVIATIONS	0.058	0.031	0.073	0.071	0.153	0.003
	0.000	0.000	0.000	0.000	0.009	0.009
EVAPOTRANSPIRATION						
TOTALS	0.479	0.492	0.660	0.847	1.739	2.208
	1.379	1.218	1.192	0.671	0.531	0.464
STD. DEVIATIONS	0.145	0.232	0.244	0.422	0.723	0.926
	0.778	0.629	0.706	0.410	0.233	0.153
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.1153	0.0977	0.1039	0.0995	0.1137	0.0921
	0.0590	0.0857	0.1185	0.1193	0.1174	0.1159
STD. DEVIATIONS	0.0391	0.0296	0.0245	0.0221	0.0247	0.0285
	0.0307	0.0574	0.0513	0.0663	0.0555	0.0509

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.28	(2.345)	2892428.2	100.00
RUNOFF	0.159	(0.1967)	34595.22	1.196
EVAPOTRANSPIRATION	11.880	(1.9659)	2587360.00	89.453
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	1.23793	(0.29041)	269621.656	9.32164
CHANGE IN WATER STORAGE	0.004	(0.7317)	851.41	0.029

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	422532.000
RUNOFF	0.865	188318.0000
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.018555	4041.28320
SNOW WATER	1.81	394220.3440

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3703

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0498

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.6224	0.1037
2	72.8516	0.3035
SNOW WATER	0.000	

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**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY        **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT3-A.D10
OUTPUT DATA FILE:           C:\HELP3\ALT3-A.OUT


TIME:  15:23     DATE:   1/13/1997


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     TITLE:  BUTTE LANDFILL Alternative 3: Pre-1991 Area

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
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                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   0
          THICKNESS                     =    24.00   INCHES
          POROSITY                      =     0.4370 VOL/VOL
          FIELD CAPACITY                =     0.1050 VOL/VOL
          WILTING POINT                 =     0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT    =     0.0986 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     = 0.440000003000E-03 CM/SEC


                                LAYER  2
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
          THICKNESS                     =   180.00   INCHES
          POROSITY                      =     0.6710 VOL/VOL
          FIELD CAPACITY                =     0.2920 VOL/VOL
          WILTING POINT                 =     0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =     0.2456 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     = 0.100000005000E-02 CM/SEC
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 500. FEET.

SCS RUNOFF CURVE NUMBER	=	74.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	51.400	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.040	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.118	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.658	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	46.577	INCHES
TOTAL INITIAL WATER	=	46.577	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.021	0.015	0.056	0.059	0.058	0.001
	0.000	0.000	0.000	0.000	0.004	0.005
STD. DEVIATIONS	0.090	0.048	0.103	0.093	0.212	0.010
	0.000	0.000	0.000	0.000	0.014	0.014
EVAPOTRANSPIRATION						
TOTALS	0.477	0.477	0.682	0.799	1.682	2.934
	1.684	1.300	1.062	0.615	0.496	0.447
STD. DEVIATIONS	0.144	0.189	0.237	0.373	0.684	0.834
	0.982	0.602	0.692	0.346	0.186	0.141
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0406	0.0362	0.0396	0.0392	0.0406	0.0403
	0.0438	0.0465	0.0440	0.0435	0.0390	0.0386
STD. DEVIATIONS	0.0408	0.0365	0.0388	0.0356	0.0351	0.0318
	0.0315	0.0297	0.0259	0.0250	0.0248	0.0259

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	2477847.0	100.00
RUNOFF	0.218 (0.2730)	40720.85	1.643
EVAPOTRANSPIRATION	12.656 (2.0637)	2361298.50	95.296
PERCOLATION/LEAKAGE THROUGH FROM LAYER 2	0.49188 (0.36409)	91775.523	3.70384
CHANGE IN WATER STORAGE	-0.085 (0.7639)	-15948.84	-0.644

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	361969.094
RUNOFF	1.269	236774.7500
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.015740	2936.79443
SNOW WATER	1.81	337715.4370

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2832
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0359

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	2.6924	0.1122
2	35.3367	0.1963
SNOW WATER	0.000	

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**        HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE              **
**         HELP MODEL VERSION 3.01  (14 OCTOBER 1994)               **
**           DEVELOPED BY ENVIRONMENTAL LABORATORY                  **
**             USAE WATERWAYS EXPERIMENT STATION                    **
**         FOR USEPA RISK REDUCTION ENGINEERING LABORATORY          **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT3-CLK.D10
OUTPUT DATA FILE:           C:\HELP3\ALT3-CLK.OUT


TIME:  14:58     DATE:  1/13/1997


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     TITLE:  Clark Tailings, Alternative 3


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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER        WERE  COMPUTED AS NEARLY
STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   5
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4570 VOL/VOL
          FIELD CAPACITY                =      0.1310 VOL/VOL
          WILTING POINT                 =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1020 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
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TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0797	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.440000003000E-03	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	3.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0432	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	240.00	INCHES
POROSITY	=	0.4190	VOL/VOL
FIELD CAPACITY	=	0.3070	VOL/VOL
WILTING POINT	=	0.1800	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3018	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 800. FEET.

SCS RUNOFF CURVE NUMBER	=	73.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	52.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.014	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.238	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.724	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	74.124	INCHES
TOTAL INITIAL WATER	=	74.124	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.020	0.013	0.052	0.055	0.055	0.000
	0.000	0.000	0.000	0.000	0.003	0.004
STD. DEVIATIONS	0.089	0.042	0.099	0.090	0.205	0.003
	0.000	0.000	0.000	0.000	0.013	0.011

EVAPOTRANSPIRATION

TOTALS	0.484	0.498	0.692	0.795	1.715	2.866
	1.524	1.324	1.080	0.624	0.496	0.458
STD. DEVIATIONS	0.142	0.201	0.230	0.376	0.707	0.845
	0.941	0.605	0.697	0.359	0.191	0.144

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0447	0.0447	0.0499	0.0481	0.0498	0.0493
	0.0588	0.0552	0.0401	0.0309	0.0286	0.0364
STD. DEVIATIONS	0.0220	0.0139	0.0143	0.0129	0.0124	0.0123
	0.0156	0.0110	0.0130	0.0202	0.0260	0.0261

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	2506771.0	100.00
RUNOFF	0.203 (0.2646)	38263.71	1.526
EVAPOTRANSPIRATION	12.553 (2.0417)	2369555.50	94.526
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.53647 (0.15013)	101264.289	4.03963
CHANGE IN WATER STORAGE	-0.012 (0.7513)	-2313.03	-0.092

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	366194.406
RUNOFF	1.267	239154.1720
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.005018	947.29199
SNOW WATER	1.81	341657.6250

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2643

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0350

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.8337	0.1390
2	0.9546	0.0795
3	0.1280	0.0427
4	70.9827	0.2958
SNOW WATER	0.000	

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**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT3-D.D10
OUTPUT DATA FILE:           C:\HELP3\ALT3-D.OUT


TIME:  15:25     DATE:   1/13/1997


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     TITLE:  Butte Landfill Alt 3- Post-1991 Area

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   5
          THICKNESS                     =      6.00   INCHES
          POROSITY                      =      0.4570 VOL/VOL
          FIELD CAPACITY                =      0.1310 VOL/VOL
          WILTING POINT                 =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.1230 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
          THICKNESS                     =     18.00   INCHES
          POROSITY                      =      0.4450 VOL/VOL
          FIELD CAPACITY                =      0.3930 VOL/VOL
          WILTING POINT                 =      0.2770 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.3270 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.300000011000E-05 CM/SEC
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LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	180.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2462	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	75.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	4.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.848	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.302	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.564	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	50.939	INCHES
TOTAL INITIAL WATER	=	50.939	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	192828.5	100.00
RUNOFF	0.209 (0.2676)	3040.91	1.577
EVAPOTRANSPIRATION	12.510 (1.9948)	181645.72	94.201
PERCOLATION/LEAKAGE THROUGH FROM LAYER 3	0.63671 (0.35509)	9245.089	4.79446
CHANGE IN WATER STORAGE	-0.076 (0.8861)	-1103.16	-0.572

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	28168.801
RUNOFF	1.260	18298.8809
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.012831	186.30380
SNOW WATER	1.81	26281.3574

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4230
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1671

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.9765	0.1627
2	5.7185	0.3177
3	36.6468	0.2036
SNOW WATER	0.000	

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**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**               DEVELOPED BY ENVIRONMENTAL LABORATORY              **
**                 USAE WATERWAYS EXPERIMENT STATION                **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY        **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT5-CLK.D10
OUTPUT DATA FILE:           C:\HELP3\ALT5-CLK.OUT

TIME:  15: 1     DATE:  1/13/1997

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     TITLE:  Clark Tailings, Alternative 5

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =     18.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0927 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	800.0	FEET

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	18.00	INCHES
POROSITY	=	0.3980	VOL/VOL
FIELD CAPACITY	=	0.2440	VOL/VOL
WILTING POINT	=	0.1360	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3980	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999997000E-06	CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	240.00	INCHES
POROSITY	=	0.4190	VOL/VOL
FIELD CAPACITY	=	0.3070	VOL/VOL
WILTING POINT	=	0.1800	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3025	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 800. FEET.

SCS RUNOFF CURVE NUMBER	=	73.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	52.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.058	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.398	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.812	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	81.621	INCHES
TOTAL INITIAL WATER	=	81.621	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.020	0.013	0.052	0.055	0.055	0.000
	0.000	0.000	0.000	0.000	0.003	0.004
STD. DEVIATIONS	0.086	0.042	0.099	0.090	0.208	0.004
	0.000	0.000	0.000	0.000	0.013	0.011
EVAPOTRANSPIRATION						
TOTALS	0.481	0.486	0.670	0.783	1.729	2.846
	1.489	1.303	1.078	0.636	0.506	0.456
STD. DEVIATIONS	0.144	0.205	0.223	0.377	0.706	0.878
	0.923	0.600	0.704	0.372	0.204	0.142
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0059	0.0311
	0.0116	0.0000	0.0001	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0380	0.1027
	0.0374	0.0000	0.0009	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0135	0.0094	0.0085	0.0070	0.0318	0.1844
	0.1584	0.0459	0.0346	0.0272	0.0232	0.0194
STD. DEVIATIONS	0.0060	0.0030	0.0022	0.0016	0.0821	0.1989
	0.1185	0.0161	0.0244	0.0185	0.0162	0.0147
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0531	0.0489	0.0547	0.0532	0.0546	0.0549
	0.0700	0.0568	0.0331	0.0243	0.0319	0.0452
STD. DEVIATIONS	0.0157	0.0127	0.0120	0.0094	0.0100	0.0108
	0.0131	0.0092	0.0167	0.0234	0.0269	0.0233

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 3						
AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0030	0.0163
	0.0061	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0192	0.0537
	0.0189	0.0000	0.0005	0.0001	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	2506771.0	100.00
RUNOFF	0.203 (0.2668)	38340.25	1.529
EVAPOTRANSPIRATION	12.463 (2.0727)	2352586.25	93.849
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.04877 (0.13682)	9205.258	0.36722
PERCOLATION/LEAKAGE THROUGH FROM LAYER 3	0.56332 (0.32285)	106331.703	4.24178
AVERAGE HEAD ACROSS TOP OF LAYER 3	0.002 (0.006)		
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.58089 (0.12257)	109648.258	4.37408
CHANGE IN WATER STORAGE	-0.016 (0.6682)	-3009.26	-0.120

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	366194.406
RUNOFF	1.269	239538.6560
DRAINAGE COLLECTED FROM LAYER 2	0.07156	13507.58590
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.036137	6821.29443
AVERAGE HEAD ACROSS LAYER 3	1.123	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.004858	917.06891
SNOW WATER	1.81	341657.6250

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2767
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0453

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	1.8321	0.1018
2	0.1920	0.0320
3	7.1640	0.3980
4	70.8384	0.2952
SNOW WATER	0.000	

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**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**           FOR USEPA RISK REDUCTION ENGINEERING LABORATORY         **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT6-LF.D10
OUTPUT DATA FILE:           C:\HELP3\ALT6-LF.OUT

TIME:  15:15     DATE:   1/13/1997

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     TITLE:  Butte Landfill, Alterantive 6

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

               TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0630 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  21
          THICKNESS                    =      3.00   INCHES
          POROSITY                     =      0.3970 VOL/VOL
          FIELD CAPACITY               =      0.0320 VOL/VOL
          WILTING POINT                =      0.0130 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.0236 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.300000012000     CM/SEC
          SLOPE                        =      4.00   PERCENT
          DRAINAGE LENGTH              =    500.0    FEET
```

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 37

THICKNESS	=	0.03	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-10	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	7.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.70	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1041	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.440000003000E-03	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	180.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2455	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 500. FEET.

SCS RUNOFF CURVE NUMBER	=	74.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	62.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.795	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.278	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.722	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	46.162	INCHES
TOTAL INITIAL WATER	=	46.162	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.019	0.013	0.051	0.056	0.056	0.000
	0.000	0.000	0.000	0.000	0.003	0.004
STD. DEVIATIONS	0.083	0.040	0.098	0.091	0.212	0.003
	0.000	0.000	0.000	0.000	0.013	0.011
EVAPOTRANSPIRATION						
TOTALS	0.476	0.460	0.620	0.761	1.733	2.635
	1.387	1.294	1.069	0.647	0.517	0.455
STD. DEVIATIONS	0.148	0.203	0.219	0.372	0.721	0.927
	0.841	0.594	0.694	0.387	0.222	0.149
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0000	0.0000	0.0009	0.0397	0.3593	0.3342
	0.0940	0.0434	0.0529	0.0507	0.0438	0.0016
STD. DEVIATIONS	0.0000	0.0000	0.0089	0.0817	0.2318	0.2738
	0.1233	0.0496	0.1003	0.0882	0.0773	0.0039
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0180	0.0158	0.0171	0.0162	0.0164	0.0155
	0.0158	0.0156	0.0148	0.0150	0.0143	0.0146
STD. DEVIATIONS	0.0432	0.0367	0.0389	0.0360	0.0355	0.0328
	0.0326	0.0316	0.0291	0.0292	0.0274	0.0273

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4						
AVERAGES	0.0000	0.0000	0.0002	0.0097	0.0853	0.0821
	0.0223	0.0103	0.0130	0.0120	0.0108	0.0004
STD. DEVIATIONS	0.0000	0.0000	0.0021	0.0200	0.0550	0.0676
	0.0293	0.0118	0.0246	0.0209	0.0190	0.0009

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.28 (2.345)	2988842.5	100.00
RUNOFF	0.203 (0.2685)	45670.19	1.528
EVAPOTRANSPIRATION	12.054 (2.0357)	2712904.25	90.768
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.02062 (0.46047)	229701.453	7.68530
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00025 (0.00008)	56.859	0.00190
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.021 (0.009)		
PERCOLATION/LEAKAGE THROUGH FROM LAYER 6	0.18920 (0.39977)	42580.465	1.42465
CHANGE IN WATER STORAGE	-0.187 (0.6301)	-42014.94	-1.406

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	436616.406
RUNOFF	1.269	285603.7810
DRAINAGE COLLECTED FROM LAYER 2	0.21216	47748.89840
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000038	8.58824
AVERAGE HEAD ACROSS LAYER 4	1.655	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.014583	3281.98389
SNOW WATER	1.81	407361.0310

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2452
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0375

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.9821	0.0818
2	0.0709	0.0236
3	0.0000	0.0000
4	0.5250	0.7500
5	0.5272	0.0879
6	25.3887	0.1410
SNOW WATER	0.000	

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**                                                                  **
**                                                                  **
**            HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE          **
**             HELP MODEL VERSION 3.01   (14 OCTOBER 1994)          **
**                DEVELOPED BY ENVIRONMENTAL LABORATORY             **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY       **
**                                                                  **
**                                                                  **
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PRECIPITATION DATA FILE:    C:\HELP3\BUTTE.D4
TEMPERATURE DATA FILE:      C:\HELP3\BUTTE.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\BUTTE.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\BUTTE3.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\ALT6-CLK.D10
OUTPUT DATA FILE:           C:\HELP3\ALT6-CLK.OUT


TIME:  15: 6     DATE:   1/13/1997


**********************************************************************

     TITLE:  Clark Tailings, Alternative 6

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
            COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   5
          THICKNESS                     =     12.00   INCHES
          POROSITY                      =      0.4570 VOL/VOL
          FIELD CAPACITY                =      0.1310 VOL/VOL
          WILTING POINT                 =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.0630 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	3.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0236	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	800.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 37

THICKNESS	=	0.03	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999999000E-10	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	7.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.70	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1042	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.440000003000E-03	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 22

THICKNESS	=	240.00	INCHES
POROSITY	=	0.4190	VOL/VOL
FIELD CAPACITY	=	0.3070	VOL/VOL
WILTING POINT	=	0.1800	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3016	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.189999992000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM A USER-SPECIFIED CURVE NUMBER OF 74.0, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 800. FEET.

SCS RUNOFF CURVE NUMBER	=	73.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	52.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.795	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	6.278	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.722	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	74.353	INCHES
TOTAL INITIAL WATER	=	74.353	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM HELENA MONTANA

MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	138
END OF GROWING SEASON (JULIAN DATE)	=	266
AVERAGE ANNUAL WIND SPEED	=	7.80 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.60	0.40	0.80	1.00	2.10	2.40
1.30	1.30	1.20	0.80	0.60	0.60

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR HELENA MONTANA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
18.00	24.00	27.00	37.00	47.00	54.00
61.00	60.00	51.00	41.00	29.00	22.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

STATION LATITUDE = 45.59 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.36	0.88	1.02	2.12	2.43
	1.34	1.25	1.25	0.85	0.59	0.58
STD. DEVIATIONS	0.34	0.24	0.47	0.54	0.93	1.17
	0.78	0.67	0.84	0.52	0.32	0.31
RUNOFF						
TOTALS	0.019	0.013	0.051	0.056	0.056	0.000
	0.000	0.000	0.000	0.000	0.003	0.004
STD. DEVIATIONS	0.083	0.040	0.098	0.090	0.211	0.002
	0.000	0.000	0.000	0.000	0.013	0.011
EVAPOTRANSPIRATION						
TOTALS	0.477	0.461	0.620	0.759	1.746	2.623
	1.383	1.297	1.065	0.658	0.517	0.456
STD. DEVIATIONS	0.148	0.206	0.220	0.369	0.720	0.926
	0.846	0.594	0.693	0.387	0.218	0.148
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0001	0.0000	0.0006	0.0299	0.3377	0.3362
	0.1220	0.0391	0.0503	0.0483	0.0421	0.0054
STD. DEVIATIONS	0.0005	0.0000	0.0060	0.0626	0.2410	0.2495
	0.1257	0.0415	0.0906	0.0819	0.0790	0.0191
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 6						
TOTALS	0.0118	0.0105	0.0115	0.0111	0.0114	0.0109
	0.0112	0.0111	0.0107	0.0110	0.0106	0.0108
STD. DEVIATIONS	0.0152	0.0135	0.0147	0.0140	0.0142	0.0136
	0.0137	0.0136	0.0130	0.0131	0.0126	0.0127

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

AVERAGES	0.0000	0.0000	0.0003	0.0156	0.1711	0.1763
	0.0618	0.0198	0.0263	0.0245	0.0220	0.0027
STD. DEVIATIONS	0.0003	0.0000	0.0031	0.0327	0.1223	0.1323
	0.0636	0.0210	0.0474	0.0415	0.0413	0.0097

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	13.28	(2.345)	2506771.0	100.00
RUNOFF	0.202	(0.2677)	38173.68	1.523
EVAPOTRANSPIRATION	12.064	(2.0263)	2277143.25	90.840
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.01161	(0.45357)	190951.219	7.61742
PERCOLATION/LEAKAGE THROUGH FROM LAYER 4	0.00044	(0.00016)	83.995	0.00335
AVERAGE HEAD ACROSS TOP OF LAYER 4	0.043	(0.020)		
PERCOLATION/LEAKAGE THROUGH FROM LAYER 6	0.13261	(0.16373)	25031.088	0.99854
CHANGE IN WATER STORAGE	-0.130	(0.5273)	-24529.48	-0.979

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	1.94	366194.406
RUNOFF	1.269	239538.6560
DRAINAGE COLLECTED FROM LAYER 2	0.12818	24195.84960
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000050	9.48944
AVERAGE HEAD ACROSS LAYER 4	2.180	
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.004035	761.64746
SNOW WATER	1.81	341657.6250
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2396	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0383	

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.9773	0.0814
2	0.0709	0.0236
3	0.0000	0.0000
4	0.5250	0.7500
5	0.5391	0.0899
6	59.2458	0.2469
SNOW WATER	0.000	

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APPENDIX E

NON-METHANOGENIC GASES GENERATION ANALYSIS

BUTTE CORRECTIVE MEASURES ASSESSMENT									
TOTAL NMOC CONCENTRATION IN LANDFILL GAS									
Project Number	**9503**								
Two samples collected from the landfill itself during the February, 1996 soil gas sampling effort.									
These samples (BSB-SG6 and BSB-SG9) were analyzed in the field for selected VOCs and in the									
lab for total NMOCs (via EPA 8260). Field results for selected NMOCs greater than field GC									
results. According to the lab (Bill Brown at Energy Labs), there may have been some photodegradation									
during transport, although all sampling procedures were followed and no QA/QC problems were reported									
by the lab.									
Constituent	**BSB-SG6**					**BSB-SG9**			
(all data mg/m^3)	**Field GC**		**Lab (8260)**			**Field GC**		**Lab (8260)**	
1,1-DCA	24.1		2.5	U		12.7		2.5	U
cis-1,2-DCE	4.1		2.5	U		2.5	J	2.5	U
1,1,1-TCA	55.6		2.5	U		2.5	U	2.5	U
TCE	2.5	J	2.5	U		2.5	U	2.5	U
PCE	2.5	U	2.5	U		2.5	U	2.5	U
Dichlorodifluoromethane			38					2.5	U
Fluorotrichloromethane			2.6					2.5	U
Toluene			11					2.5	U
Other NMOCs			137.5	U				137.5	U
(all other NMOCs on the 8260 list, all were not detected at 2.5 mg/m^3; value reported is sum of the detection limits)									
SUM (all U and J data are considered to be present at reported detection limit (2.5)	88.8	mg/m^3	201.6	mg/m^3		22.7	mg/m^3	157.5	mg/m^3
Convert to g-moles/m^3 as hexane	0.00103	g-mol/m^3	0.00234	g-mol/m^3		0.00026	g-mol/m^3	0.00183	g-mol/m^3
Convert to volume of hexane (assume ideal gas at STP=22.4 liters per g-mole)	2.31E-05	m^3 hexane/ m^3 air	5.24E-05	m^3 hexane/ m^3 air		5.90E-06	m^3 hexane/ m^3 air	4.09E-05	m^3 hexane/ m^3 air
ppmv NMOC in air as hexane	23	ppmv	52	ppmv		6	ppmv	41	ppmv
	23.1		52.4			5.9		41.0	
Conclusion: Based on these data, both the CAA amendments (4000 ppmv) and the AP-42 (595 ppmv) assumptions for NMOC concentrations are very conservative. Therefore, the less conservative defaults (AP-42) will be used for the EPA Landfill Air Emissions Estimation Model input. These are still expected to overestimate the actual NMOC emissions, based on these data. However, there may have been some degradation of the NMOC components during shipping; therefore the lab data may underestimate the total NMOC concentrations. In the field, only selected NMOCs were analyzed. Even if a factor of 10 is applied to the worst case from these data (BSB-A6 lab analysis, with all non-detects considered to be present at the detection limit), it is still below the total NMOC default value for AP-42.									

Checked 12/16/96

BUTTE CORRECTIVE MEASURES ASSESSMENT									
LANDFILL AIR EMISSIONS ESTIMATION MODEL INPUT									
Project Number		9503							
LANDFILL CAPACITY									
From data included in Section 3 of CMA report:									
Estimate	1.20E+06	cy in place							
Estimate	1000	lb/cy							
Calculate	600000	tons in place							
Calculate	1.2E+09	lbs in place							
Conversion	0.000454	Mg per pound							
Calculate	544800	Mg in place							
Estimate	600000	Mg capacity							
ANNUAL ACCEPTANCE RATE									
Years of Operation: 1968 to 1993 =				25	years				
Calculate	(Mass in place/years)		=	21792	Mg per year from 1968 to 1993				
Estimate				1000	10-yd C&D end dumps per year, 1994 and 1995				
Estimate				1000	lb/cy in end dumps				
Calculate				1000000	lb per year, 1994 and 1995				
Convert				454	Mg per year, 1994 and 1995				

Model Parameters AP-42 DEFAULT

Lo : 124.91 m^3 / Mg
k : 0.0400 1/yr
NMOC : 595.00 ppmv
Methane : 50.0000 % volume
Carbon Dioxide : 50.0000 % volume

Landfill Parameters

Year Opened : 1968 Current Year : 1996 Year Closed: 1996
Capacity : 567700 Mg
Average Acceptance Rate Required from
Current Year to Closure Year : 0.00 Mg/year

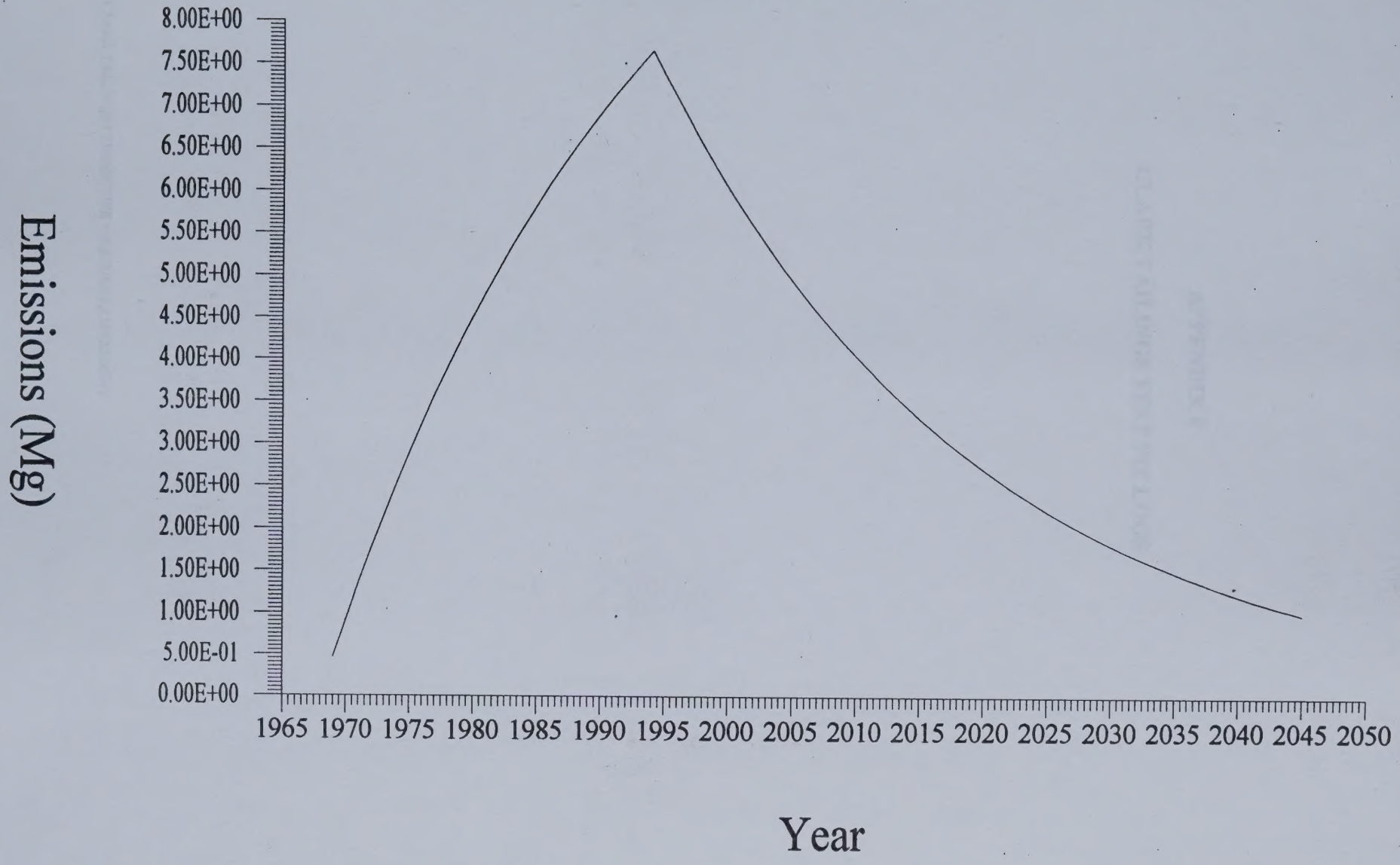
Model Results

Year	Refuse In Place (Mg)	NMOC Emission Rate (Mg/yr)	NMOC Emission Rate (Cubic m/yr)
1969	2.180E+04	4.646E-01	1.296E+02
1970	4.360E+04	9.110E-01	2.541E+02
1971	6.540E+04	1.340E+00	3.738E+02
1972	8.720E+04	1.752E+00	4.887E+02
1973	1.090E+05	2.148E+00	5.992E+02
1974	1.308E+05	2.528E+00	7.053E+02
1975	1.526E+05	2.894E+00	8.073E+02
1976	1.744E+05	3.245E+00	9.052E+02
1977	1.962E+05	3.582E+00	9.993E+02
1978	2.180E+05	3.906E+00	1.090E+03
1979	2.398E+05	4.218E+00	1.177E+03
1980	2.616E+05	4.517E+00	1.260E+03
1981	2.834E+05	4.804E+00	1.340E+03
1982	3.052E+05	5.081E+00	1.417E+03
1983	3.270E+05	5.346E+00	1.491E+03
1984	3.488E+05	5.601E+00	1.563E+03
1985	3.706E+05	5.846E+00	1.631E+03
1986	3.924E+05	6.081E+00	1.697E+03
1987	4.142E+05	6.307E+00	1.760E+03
1988	4.360E+05	6.525E+00	1.820E+03
1989	4.578E+05	6.733E+00	1.879E+03
1990	4.796E+05	6.934E+00	1.934E+03
1991	5.014E+05	7.127E+00	1.988E+03
1992	5.232E+05	7.312E+00	2.040E+03
1993	5.450E+05	7.490E+00	2.089E+03
1994	5.668E+05	7.661E+00	2.137E+03
1995	5.672E+05	7.370E+00	2.056E+03
1996	5.677E+05	7.090E+00	1.978E+03
1997	5.677E+05	6.812E+00	1.901E+03
1998	5.677E+05	6.545E+00	1.826E+03
1999	5.677E+05	6.289E+00	1.754E+03
2000	5.677E+05	6.042E+00	1.686E+03
2001	5.677E+05	5.805E+00	1.620E+03
2002	5.677E+05	5.578E+00	1.556E+03
2003	5.677E+05	5.359E+00	1.495E+03
2004	5.677E+05	5.149E+00	1.436E+03
2005	5.677E+05	4.947E+00	1.380E+03
2006	5.677E+05	4.753E+00	1.326E+03
2007	5.677E+05	4.567E+00	1.274E+03
2008	5.677E+05	4.387E+00	1.224E+03
2009	5.677E+05	4.215E+00	1.176E+03

2010	5.677E+05	4.050E+00	1.130E+03
2011	5.677E+05	3.891E+00	1.086E+03
2012	5.677E+05	3.739E+00	1.043E+03
2013	5.677E+05	3.592E+00	1.002E+03
2014	5.677E+05	3.451E+00	9.629E+02
2015	5.677E+05	3.316E+00	9.251E+02
2016	5.677E+05	3.186E+00	8.888E+02
2017	5.677E+05	3.061E+00	8.540E+02
2018	5.677E+05	2.941E+00	8.205E+02
2019	5.677E+05	2.826E+00	7.883E+02
2020	5.677E+05	2.715E+00	7.574E+02
2021	5.677E+05	2.608E+00	7.277E+02
2022	5.677E+05	2.506E+00	6.992E+02
2023	5.677E+05	2.408E+00	6.718E+02
2024	5.677E+05	2.313E+00	6.454E+02
2025	5.677E+05	2.223E+00	6.201E+02
2026	5.677E+05	2.136E+00	5.958E+02
2027	5.677E+05	2.052E+00	5.724E+02
2028	5.677E+05	1.971E+00	5.500E+02
2029	5.677E+05	1.894E+00	5.284E+02
2030	5.677E+05	1.820E+00	5.077E+02
2031	5.677E+05	1.748E+00	4.878E+02
2032	5.677E+05	1.680E+00	4.687E+02
2033	5.677E+05	1.614E+00	4.503E+02
2034	5.677E+05	1.551E+00	4.326E+02
2035	5.677E+05	1.490E+00	4.157E+02
2036	5.677E+05	1.432E+00	3.994E+02
2037	5.677E+05	1.375E+00	3.837E+02
2038	5.677E+05	1.321E+00	3.687E+02
2039	5.677E+05	1.270E+00	3.542E+02
2040	5.677E+05	1.220E+00	3.403E+02
2041	5.677E+05	1.172E+00	3.270E+02
2042	5.677E+05	1.126E+00	3.142E+02
2043	5.677E+05	1.082E+00	3.018E+02
2044	5.677E+05	1.040E+00	2.900E+02
2045	5.677E+05	9.988E-01	2.786E+02

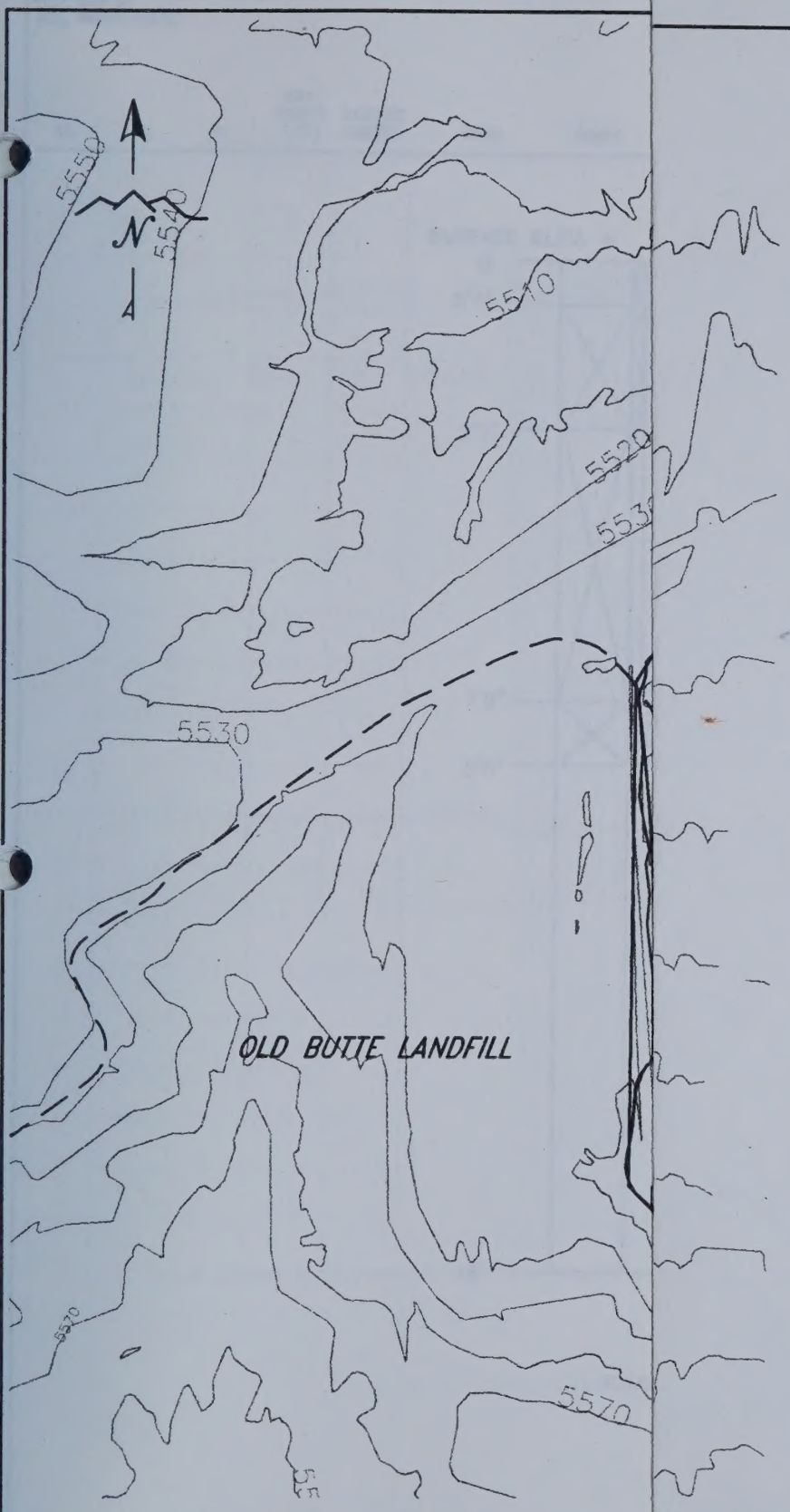
Projected NMOC Emissions

AP-42 DEFAULTS



APPENDIX F

CLARK TAILINGS TEST PIT LOGS



5490

5490

LEGEND

CONTOUR INTERVAL= 10'

CT-P TEST PITS

FIGURE
OLD LANDFILL/
CLARK TAILINGS
TEST PITS

SCALE: 1"=400'
DATE: 2/4/97

NEER
SERVICES, INC.

4502-F21

CLARK TAILINGS

OLD BUTTE LANDFILL

CTP-22
CTP-24
CTP-23
CTP-25
CTP-12
CTP-17
CTP-10
CTP-21
CTP-11
CTP-26
CTP 9
CTP-13
CTP-14
CTP-18
CTP-20
CTP-15
CTP-27
CTP 8
CTP-19
CTP 7
CTP-16
CTP-28
CTP 5
CTP 6
CTP 4
CTP-29
CTP-34
CTP-33
CTP 3
CTP-30
CTP 2
CTP-31
CPT 1
CTP-32
PCK-1

5550 5540 5530 5520 5510 5500 5490 5480 5570 5560

LEGEND

CONTOUR INTERVAL= 10'

CT-P TEST PITS

PIONEER TECHNICAL SERVICES, INC.

FIGURE
OLD LANDFILL/
CLARK TAILINGS
TEST PITS

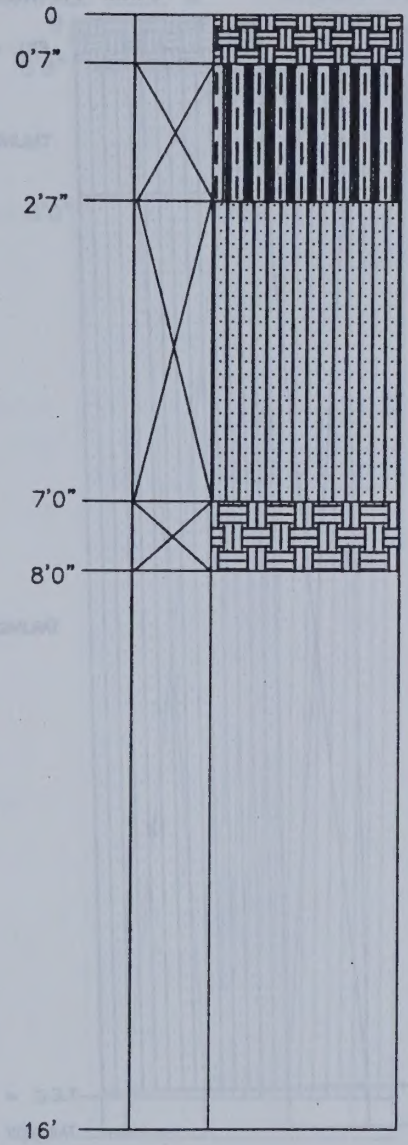
SCALE: 1"=400'
DATE: 2/4/97

4502-F21

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – GRAY – CLAY.

TAILINGS – YELLOW AND TAN – FINE SAND.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND.

T.E.D. = 8'0"

TOTAL EXCAVATED DEPTH = 8'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 01

FIGURE 01

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 01
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-87

CTP01

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					0'7"			FILL – DRK. BROWN, MEDIUM SAND LOAM.
								TAILINGS – ORANGE AND RED – FINE SAND .
					2'7"			
								TAILINGS – GRAY – FINE SAND .
								T.E.D. = 15'4"
					16'			TAILINGS CONTINUE TO AN UNKNOWN DEPTH.

TOTAL EXCAVATED DEPTH = 15'4" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 02

FIGURE 02

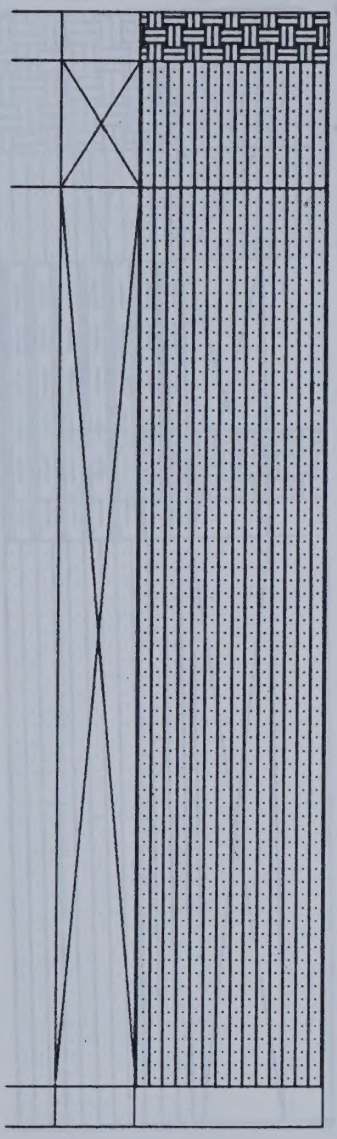
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 02
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP02

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE AND RED – FINE SAND .

TAILINGS – GRAY – FINE SAND WITH CLAY LENSES .

T.E.D. = 15'4"

TAILINGS CONTINUE TO AN UNKNOWN DEPTH.

TOTAL EXCAVATED DEPTH = 15'4" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 03

FIGURE 03

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 03
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP03

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. =			
					0			FILL – DRK. BROWN, MEDIUM SAND LOAM.
					2'0"			TAILINGS – ORANGE AND RED – FINE SAND
					3'6"			TAILINGS – GRAY – CLAY
					7'6"			TAILINGS – TAN– FINE SAND
					16'			T.E.D. = 16'0" TAILINGS CONTINUE FOR UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 16'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 04

FIGURE 04

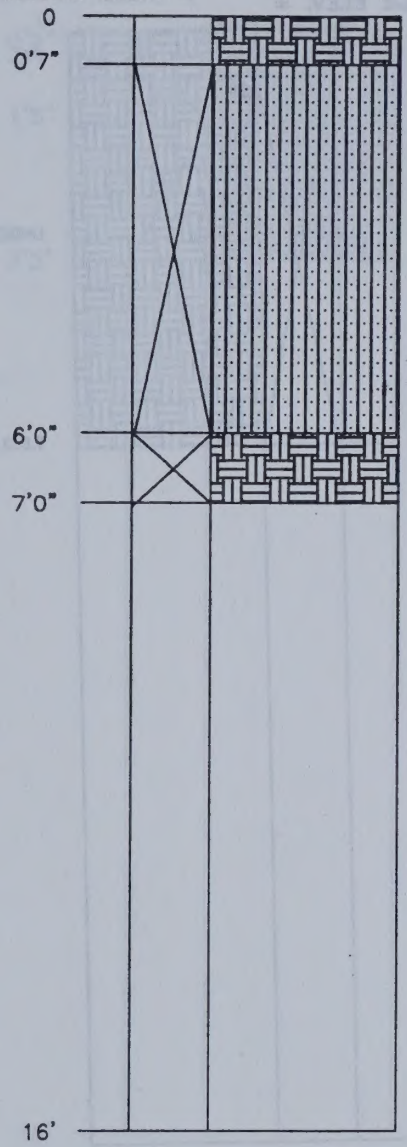
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 04
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-87

CTP04

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE AND RED – FINE SAND

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND LOAM.

T.E.D. = 7'0"

TAILINGS CONTINUE FOR UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 7'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 05

FIGURE 05

PROJECT: CLARK TAILINGS TEST PIT

LOCATION (STA & OFFSET): CTP 05

CLIENT: ARCO

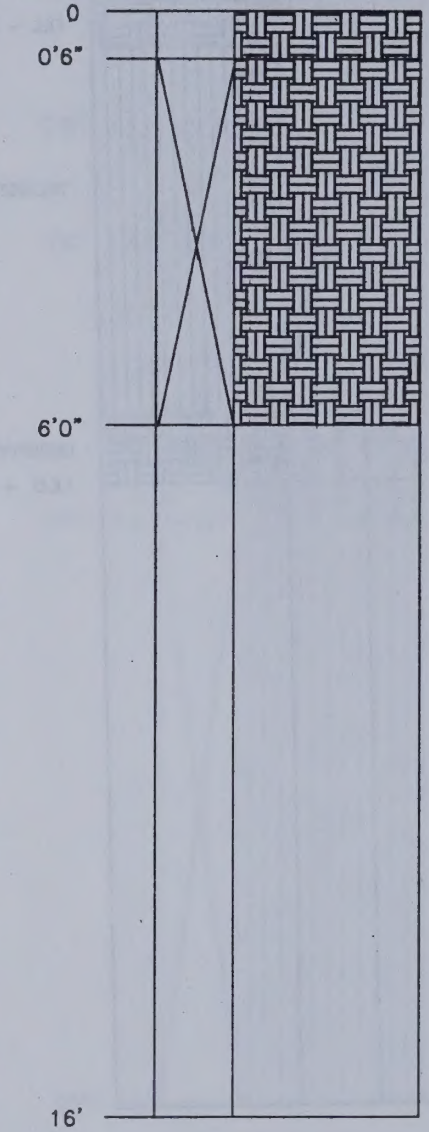
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP05

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND LOAM.

T.E.D. = 6'0"

TAILINGS CONTINUE FOR UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 6'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 06

FIGURE 06

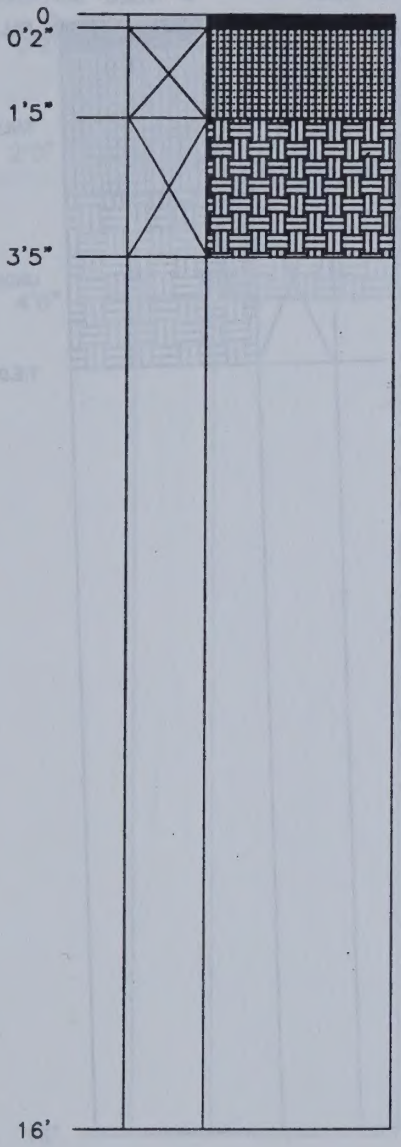
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 06
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP06

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE, YELLOW, AND TAN – FINE SAND.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND LOAM.

T.E.D. = 3'5"

TOTAL EXCAVATED DEPTH = 3'5" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 07

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 07
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

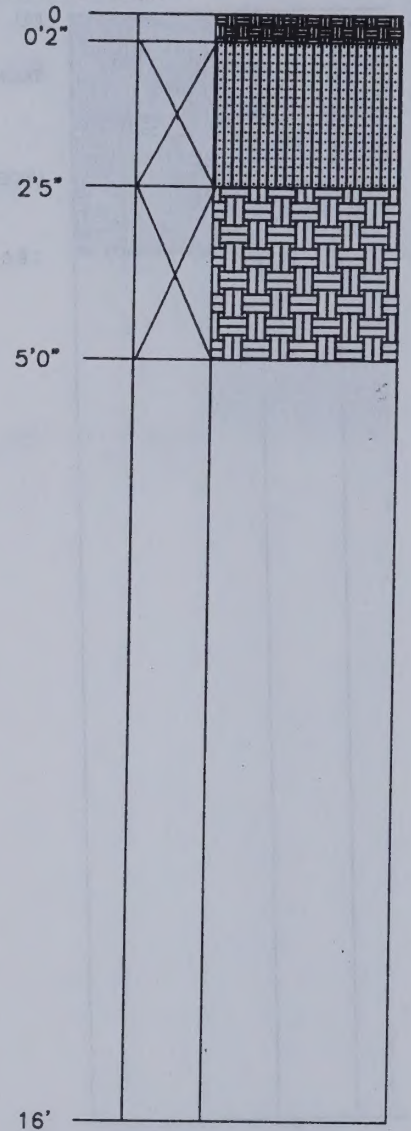
FIGURE 07

CTP07

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE, YELLOW, AND TAN – FINE SAND.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND LOAM.

T.E.D. = 5'0"

TOTAL EXCAVATED DEPTH = 5'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 08

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 08
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

FIGURE 08

CTP08

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =

FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE, YELLOW, AND TAN – FINE SAND.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND LOAM.

T.E.D. = 4'0"

TOTAL EXCAVATED DEPTH = 4'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 09

FIGURE 09

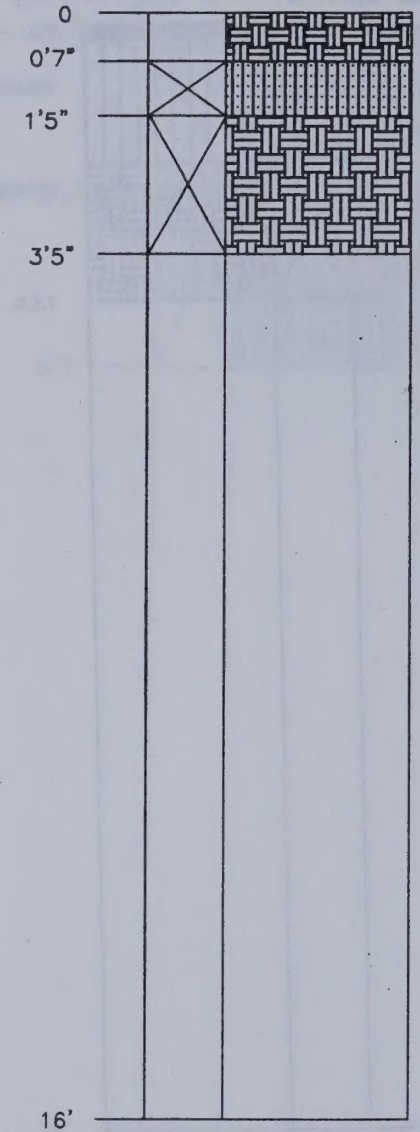
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 09
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW
STATE: MONTANA
DATE: 1-10-97

CTP09

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – YELLOW AND TAN – FINE SAND.

UNDERLYING SOIL – DRK. BROWN, MEDIUM SAND.

T.E.D. = 3'5"

TOTAL EXCAVATED DEPTH = 3'5" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 10

FIGURE 10

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 10
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

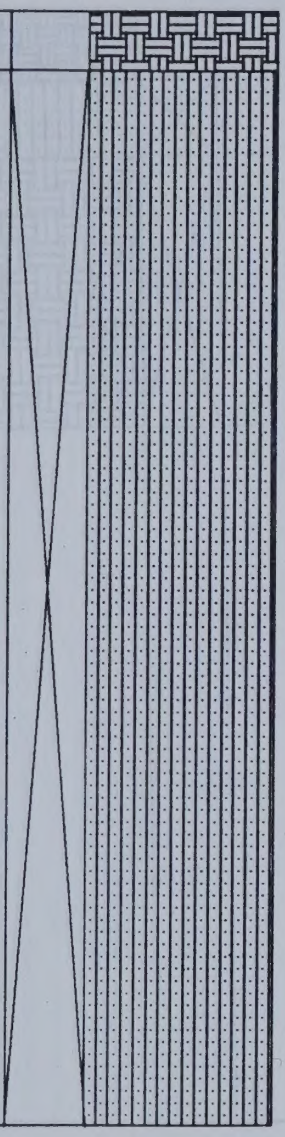
CTP10

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =

0



0'10"

FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – YELLOW AND TAN – FINE SAND.

16'

T.E.D. = 16'0"

Tailings continue to an unknown depth

TOTAL EXCAVATED DEPTH = 16'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 11

FIGURE 11

PROJECT: CLARK TAILINGS TEST PIT

LOCATION (STA & OFFSET): CTP 11

CLIENT: ARCO

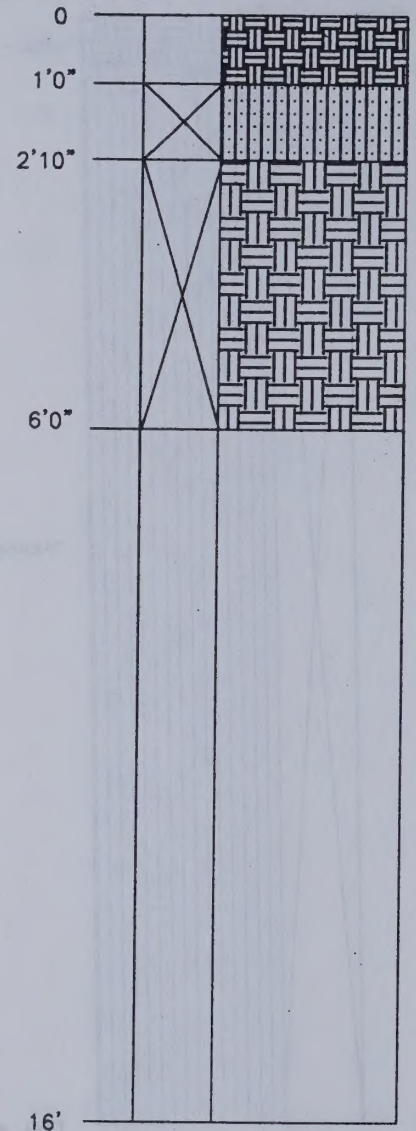
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP11

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – ORANGE AND YELLOW – FINE SAND.

UNDERLYING SOIL – BRN MEDIUM SAND.

T.E.D. = 6'0"

TOTAL EXCAVATED DEPTH = 6'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 12

FIGURE 12

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 12
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW
STATE: MONTANA
DATE: 1-10-97

CTP12

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. = 0

0'10" — FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – YELLOW AND TAN – FINE SAND.

16' — T.E.D. = 16'0"

Tailings continue to an unknown depth

TOTAL EXCAVATED DEPTH = 16'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 13

FIGURE 13

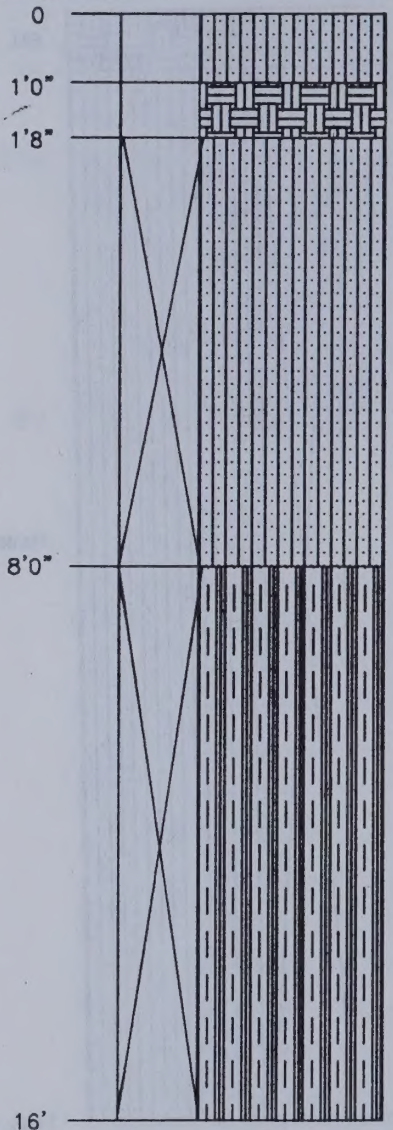
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 13
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW
STATE: MONTANA
DATE: 1-10-97

CTP13

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



TAILINGS – TAN – FINE SAND

FILL – DRK. BROWN, MEDIUM SAND LOAM.

TAILINGS – TAN AND ORANGE – FINE SAND

TAILINGS – GRAY – CLAY

T.E.D. = 16'0"

Tailings continue to an unknown depth

TOTAL EXCAVATED DEPTH = 16'0" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 14

FIGURE 14

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 14
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 1-10-97

CTP14

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					0'10"			FILL – BROWN, SANDY LOAM.
								TAILINGS, ORANGE, FINE SAND.
					3'4"			
								TAILINGS, GRAY, FINE SAND WITH CLAY LENSES.
					16'			T.E.D. = 16'0"

TAILINGS CONTINUE TO AN UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 15

FIGURE 15

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 15
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-10-97

TP15

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					1'0"			FILL – BROWN, SANDY LOAM.
								TAILINGS, YELLOW AND TAN, FINE SAND.
					7'5"			TAILINGS, GRAY, FINE SAND WITH GRAY LENSES.
					16'			T.E.D. = 16'0"
								TAILINGS CONTINUE AT AN UNKNOWN DEPTH.

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 16

FIGURE 16

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 16
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-10-97

TP16

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
								TAILINGS – TAN, MEDIUM–FINE SAND (SM). SOME NATIVE SOILS MIXED IN.
					6'6"			TAILINGS – TAN, FINE SAND.
					12'6"			TAILINGS – GRAY, CLAY.
					16'			T.E.D. – 16'0"
								TAILINGS CONTINUE TO AN UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 17

FIGURE 17

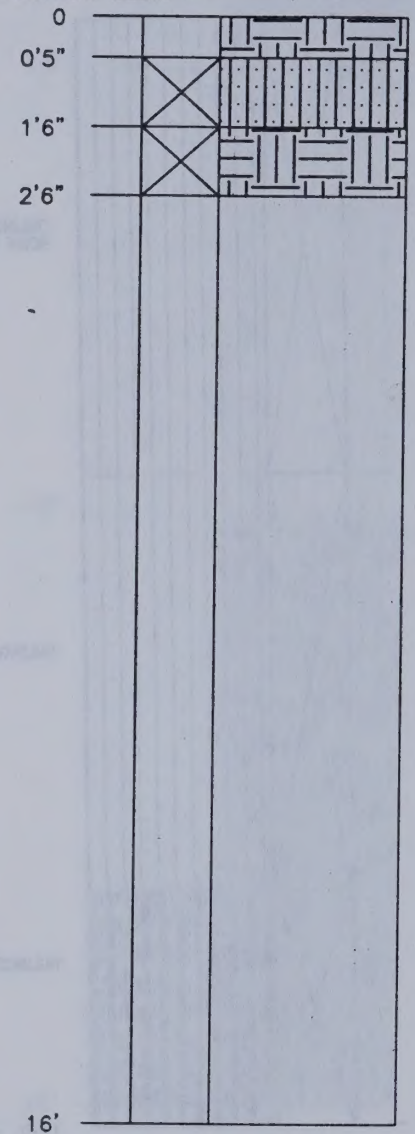
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 17
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-10-97

TP17

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS – ORANGE, FINE SAND.

UNDERLYING NATIVE SOIL – BROWN, MEDIUM SANDY LOAM.

T.E.D. = 2'6"

TOTAL EXCAVATED DEPTH = 2'6" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 18

FIGURE 18

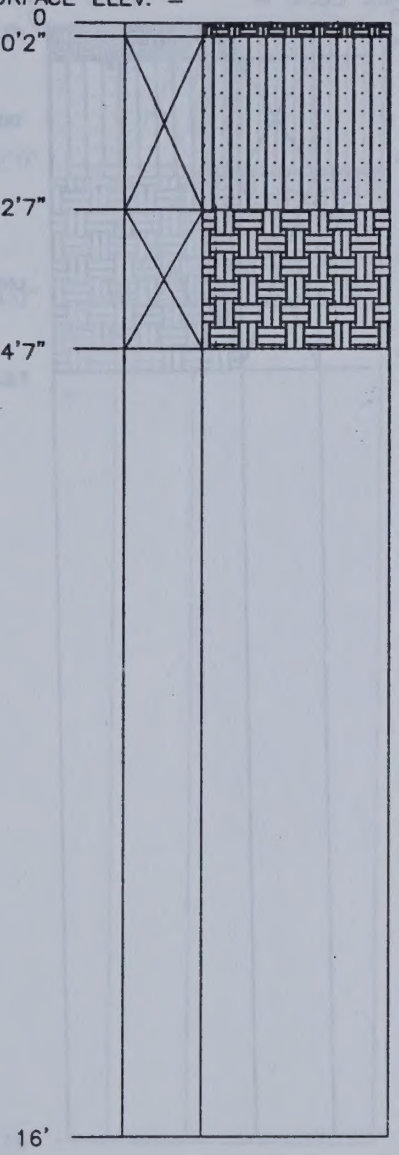
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 18
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP18

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS – ORANGE, FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. = 4'7"

TOTAL EXCAVATED DEPTH = 4'7".

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 19

FIGURE 19

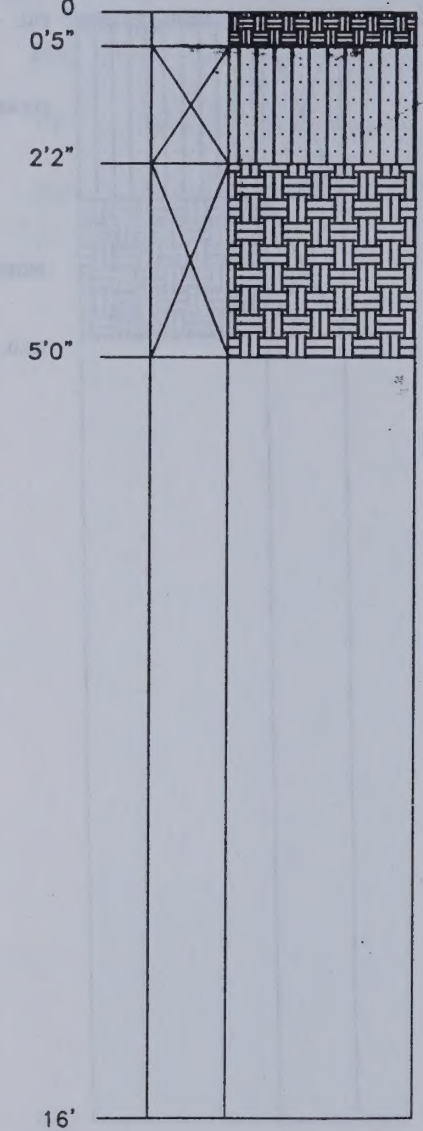
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 19
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP19

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS – ORANGE, FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. = 5'0"

TOTAL EXCAVATED DEPTH = 5 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 20

FIGURE 20

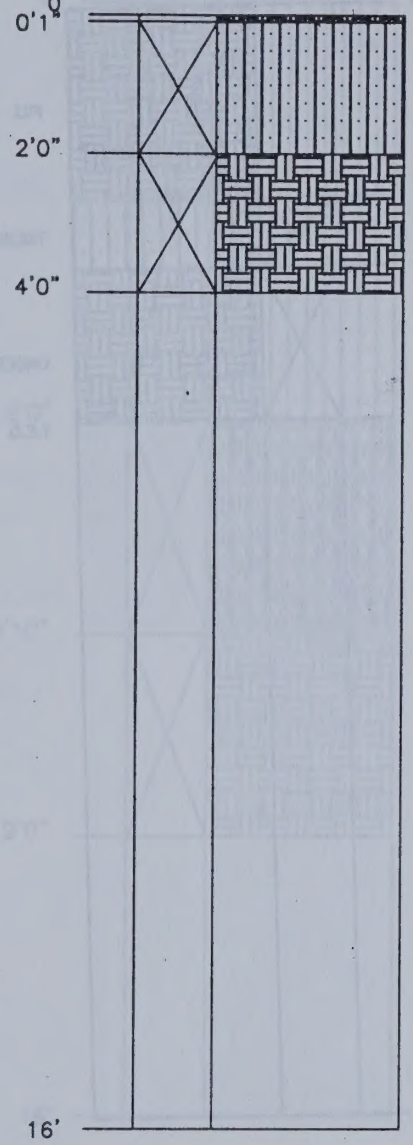
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 20
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP20

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS – YELLOW, FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. 4.0

TOTAL EXCAVATED DEPTH = 4 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 21

FIGURE 21

PROJECT: CLARK TAILINGS TEST PIT

LOCATION (STA & OFFSET): CTP 21

CLIENT: ARCO

LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP21

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			FILL – BROWN, SANDY LOAM.
					2'8"			TAILINGS – YELLOW, FINE SAND.
					3'8"			UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.
					6'0"			T.E.D. 6'0"
					16'			

TOTAL EXCAVATED DEPTH = 6 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 22

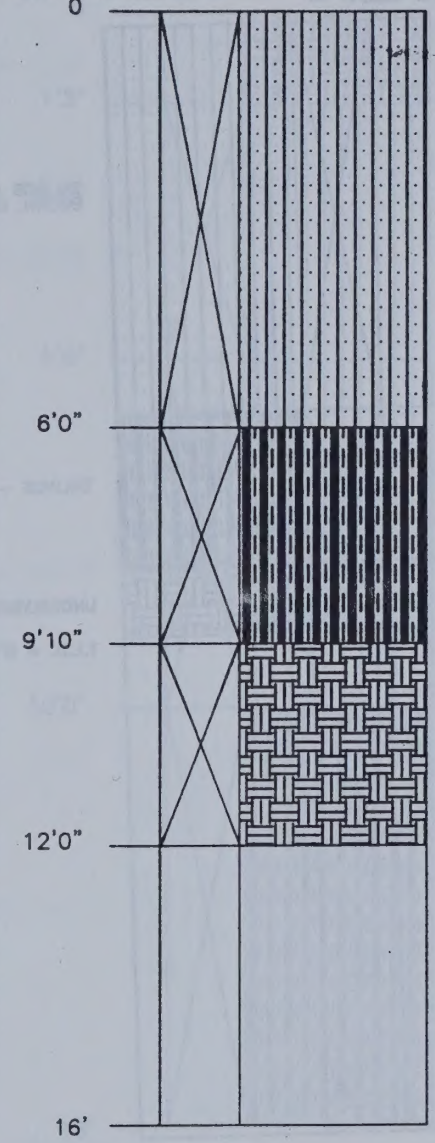
FIGURE 22

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 22
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP22

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			TAILINGS MIXED WITH NATIVE SOIL BROWN, TAN, ORANGE, FINE SAND.
					6'0"			TAILINGS, GRAY – FINE SAND WITH CLAY LENSES.
					9'10"			UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.
					12'0"			T.E.D. 12'0"
					16'			



TOTAL EXCAVATED DEPTH = 12 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 23

FIGURE 23

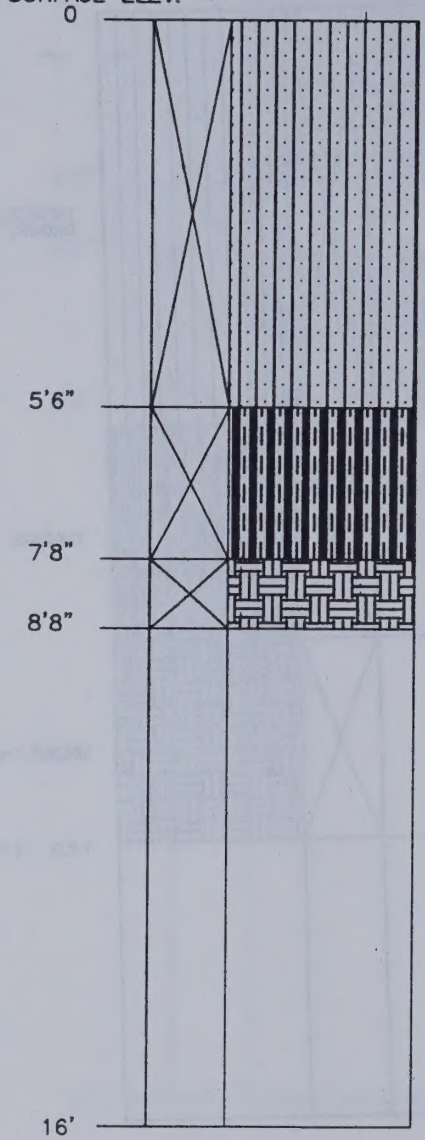
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 23
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP23

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



TAILINGS MIXED WITH NATIVE SOIL BROWN, ORANGE, YELLOW, FINE SAND.

TAILINGS – GRAY, CLAY.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. = 8'8"

TOTAL EXCAVATED DEPTH = 8'8" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 24

FIGURE 24

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 24
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP24

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					1'3"			FILL – BROWN, SANDY LOAM.
								TAILINGS MIXED WITH NATIVE SOIL ORANGE, YELLOW, BROWN (MOSTLY TAILS), FINE SAND.
					5'0"			TAILINGS, TAN, FINE SAND.
					10'0"			TAILINGS, GRAY, CLAY.
					16'			T.E.D. 16'0"

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 25

FIGURE 25

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 25
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP25

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			FILL – TOPSOIL AND COBBLE SIZE ROCK.
					1'3"			TAILINGS MIXED WITH NATIVE SOIL BROWN, ORANGE, MEDIUM FINE SAND.
					5'7"			TAILINGS, TAN, FINE SAND.
					10'5"			TAILINGS, GRAY, CLAY.
					16'			T.E.D. 16'0"
								TAILINGS CONTINUE TO UNKNOWN DEPTH,

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 26

FIGURE 26

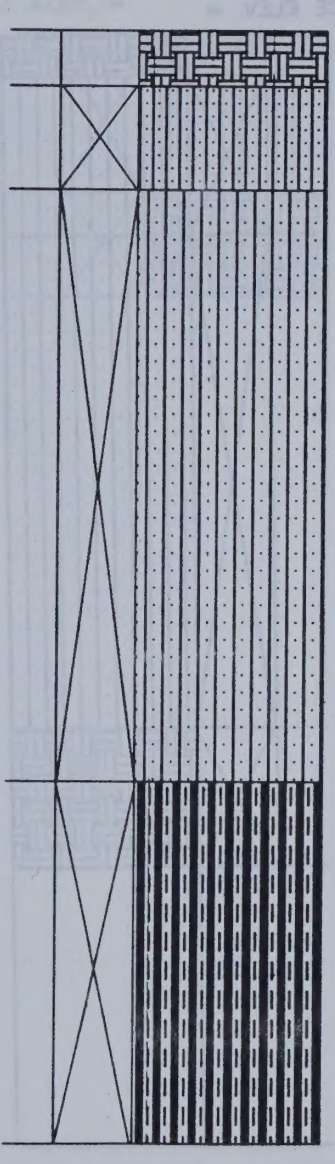
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 26
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP26

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL– BROWN, SANDY LOAM.

TAILINGS MIXED WITH NATIVE SOIL ORANGE, BROWN, MEDIUM TO FINE SAND.

TAILINGS – YELLOW AND TAN, FINE SAND.

TAILINGS, GRAY, CLAY.

T.E.D. 16'0"

TAILINGS CONTINUE TO AN UNKNOWN DEPTH

TOTAL EXCAVATED DEPTH = 16 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 27

FIGURE 27

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 27
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP27

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					0'6"			FILL – BROWN, SANDY LOAM.
								TAILINGS MIXED WITH NATIVE SOIL BROWN AND ORANGE, MEDIUM, FINE SAND.
					2'9"			
								TAILINGS – YELLOW AND TAN, FINE SAND.
					10'0"			UNDERLYING NATIVE SOIL, BROWN, MEDIUM SAND LOAM.
					12'0"			T.E.D. 12'0"
					16'			

TOTAL EXCAVATED DEPTH = 12 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 28

FIGURE 28

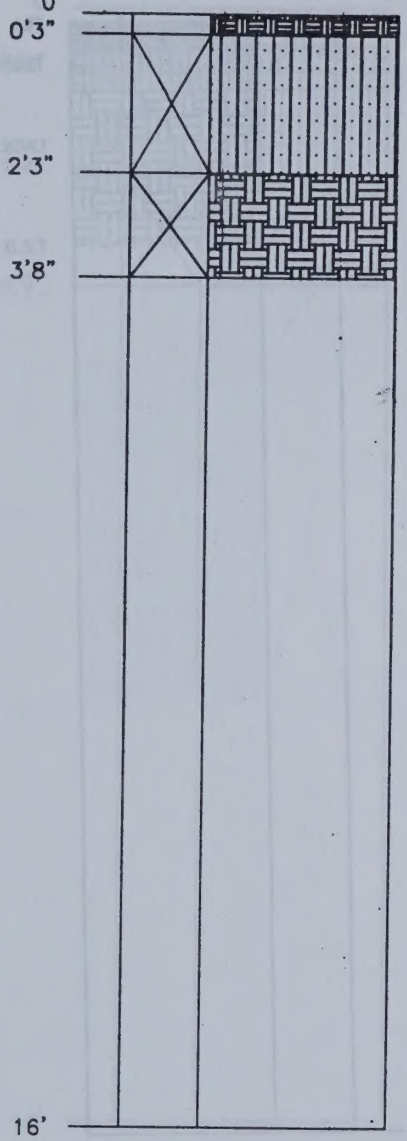
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 28
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-87

TP28

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. = 0



FILL – BROWN, SANDY LOAM.

TAILINGS MIXED WITH NATIVE SOIL BROWN, ORANGE, MEDIUM FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. 3'8"

TOTAL EXCAVATED DEPTH = 3'8" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 29

FIGURE 29

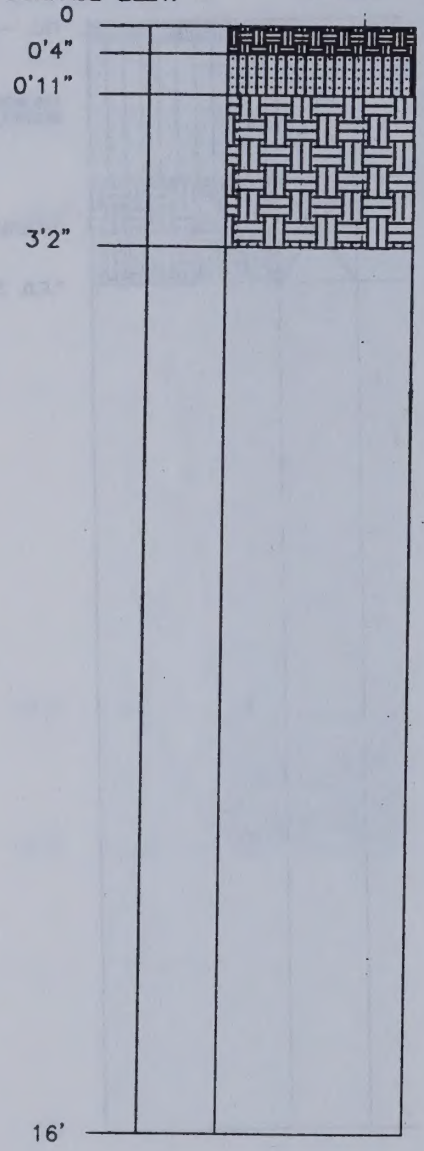
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 29
CLIENT: ARCO
LOCATION: BUTTE, SILVER BOW STATE: MONTANA DATE: 01-15-97

TP29

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS – ORANGE, FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. 3'2"

TOTAL EXCAVATED DEPTH = 3'2" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 30

PROJECT: CLARK TAILINGS TEST PIT

LOCATION (STA & OFFSET): CTP 30

CLIENT: ARCO

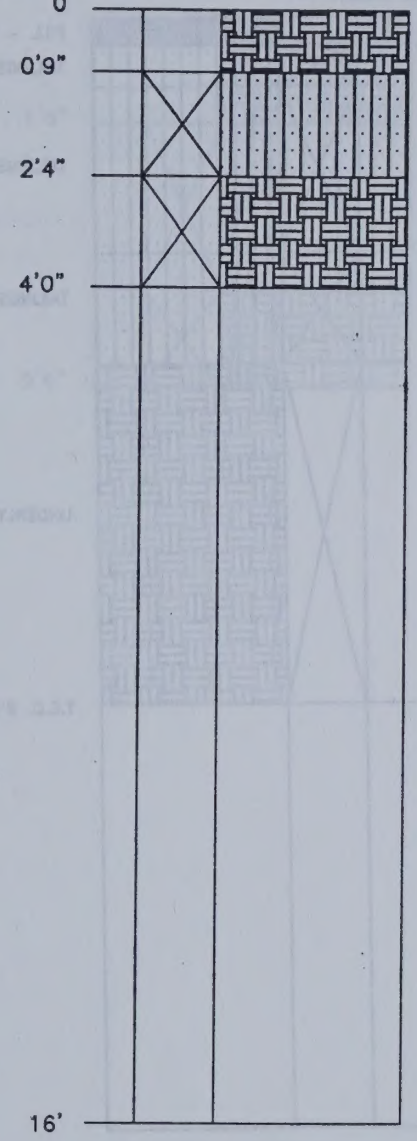
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

FIGURE 30

TP30

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. = 0			
					0'9"			FILL – BROWN, SANDY LOAM.
					2'4"			TAILINGS, ORANGE AND TAN, FINE SAND.
					4'0"			UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.
					16'			T.E.D. 4'0"



TOTAL EXCAVATED DEPTH = 4 FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 31

FIGURE 31

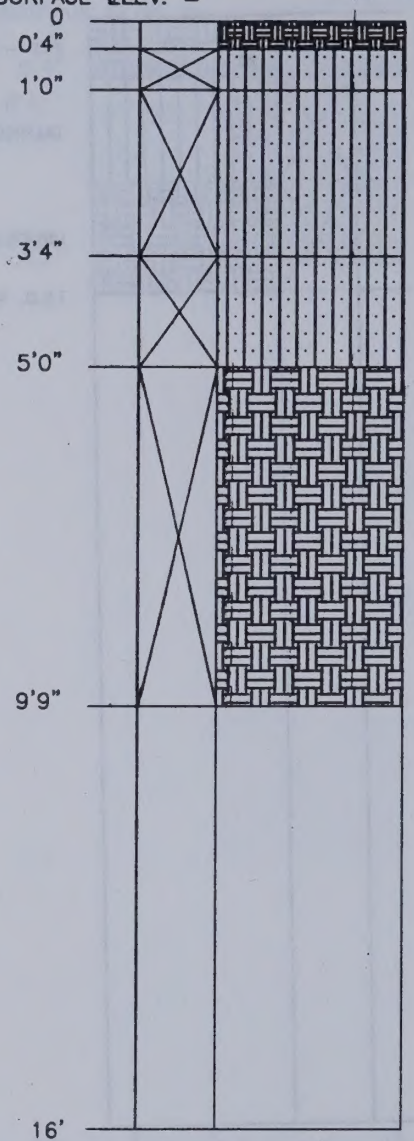
PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 31
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

TP31

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION

SURFACE ELEV. =



FILL – BROWN, SANDY LOAM.

TAILINGS, ORANGE AND TAN, FINE SAND.

TAILINGS, TAN, FINE SAND.

TAILINGS, ORANGE AND YELLOW, FINE SAND.

UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.

T.E.D. 9'9"

TOTAL EXCAVATED DEPTH = 9'9" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 32

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 32
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MONTANA DATE: 01-15-97

FIGURE 32

TP32

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION
					SURFACE ELEV. =			
					0			FILL – BROWN, SANDY LOAM.
					1'6"			TAILINGS, YELLOW, ORANGE AND TAN, FINE SAND.
					4'0"			UNDERLYING NATIVE SOIL, BROWN, MEDIUM SANDY LOAM.
					5'4"			T.E.D. = 5'4"
					16'			

TOTAL EXCAVATED DEPTH = 5'4" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 33

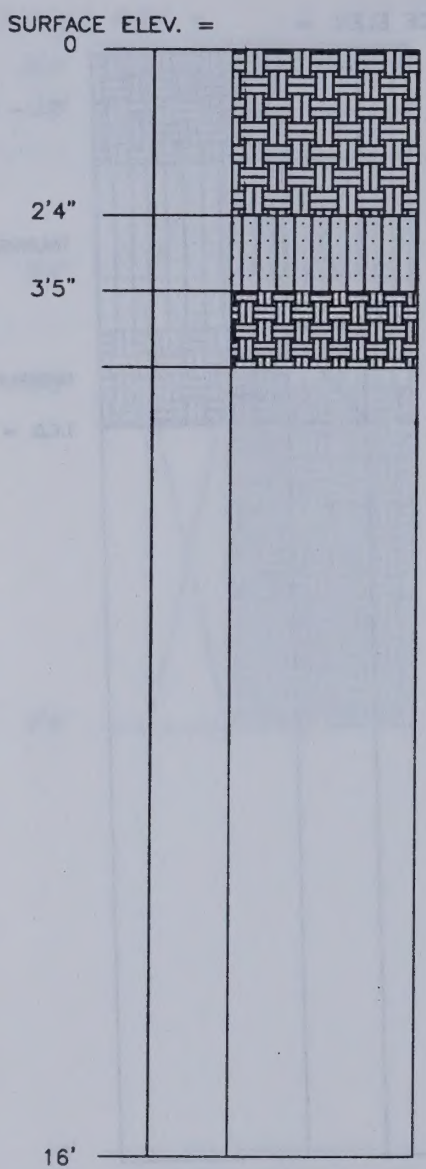
FIGURE 33

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 33
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MT DATE: 01-15-97

TP33

☒ GRAB OR BAGGED SAMPLE

LL	PL	PI	DRY DENSITY (PCF)	MOISTURE CONTENT	DEPTH	SAMPLE	GRAPHIC LOG	DESCRIPTION



TOTAL EXCAVATED DEPTH = 3'5" FT.

PIONEER TECHNICAL SERVICES, INC.

LOG OF TEST PIT 34

FIGURE 34

PROJECT: CLARK TAILINGS TEST PIT
LOCATION (STA & OFFSET): CTP 34
CLIENT: ARCO
LOCATION: BUTTE SILVER BOW STATE: MT DATE: 01-15-97

TP34

APPENDIX G

TIME TO COMPLIANCE CALCULATIONS

TIME TO IMPROVEMENTS TO WATER QUALITY DOWNGRADIENT OF TIMBER BUTTE SED BASIN

Data/Assumptions:

Tailings

$\phi_{tlgs.}$=	0.3	
$Sw_{tlgs.}$=	0.6	(water saturation in tailings) Sw=(vol. of fluid in media)/(total vol. of voids)
$Sirr_{tlgs.}$=	0.12	(irreducible water saturation)
$Kv_{tlgs.}$=	0.035	ft/day(vertical perm. of tailings=.25 of Kh=5*10^{-5}cm/sec.)
$(dH/dL)_{tlg}$=	1	ft./ft. (approximate drainage gradient in unsaturated envrionment)
h_{tlgs} =	25	ft

Capillary pressure effects in draining tailings can be neglected.

Aquifer

$Kh_{aq.}$=	2.835	ft/day(horizontal perm. of aquifer=1*10^{-3}cm/sec.)
$Kh_{aq.}$=	14.173	ft/day(horizontal perm. of aquifer=5*10^{-3}cm/sec.)
$(dH/dL)_{aq.}$=	0.0425	ft./ft. (from Figure 2-6)
$h_{aq,avg.}$=	25	ft.
w=	375	ft. (width of basin)
l=	525	ft. (length from upgradient edge of basin to CLK-1)
Surf. Area=	200800	sq. ft (area of sed basin)
$Sw_{aq.}$=	1	
$\phi_{aq.}$=	0.25	

Viscosity of water equals 1 cp.

Volume of Water in Aquifer underlying sed basin

$Vw=V*\phi$

V=A*h=	5020000	ft^3
Vw=	1255000	ft^3

Flow Rate through Aquifer

q=K*A*(dH/dL)

q=	1129	ft^3 /day	at Kh_{aq}=1.0e-03 cm/sec
q=	5647	ft^3 /day	at Kh_{aq}=5.0e-03 cm/sec

Time Required for Water to Drain from Tailings to Aquifer

(see previous sheet)

t=	1342	days =	3.7	years

Estimated Time Required to Achieve to flush aquifer and see improvements at CLK-1

After water has drained from tailings (see above), estimate that one flush of the aquifer underlying the sed basin will be required to observe improvements in water quality.

At Kh_{aq} = 1.0E-03 cm/sec

$t_{1\ flush}$=	1111	days=	3.0	years

Total time to see improvements downgradient of CLK-1	6.7	years

BSB LANDFILL TIME TO COMPLIANCE

Data/Assumptions:

Aquifer

$Kh_{aq.}$=	2.835	ft/day(horizontal perm. of aquifer=1*10^{-3}cm/sec.)
$Kh_{aq.}$=	14.173	ft/day(horizontal perm. of aquifer=5*10^{-3}cm/sec.)
$(dH/dL)_{aq.}$	0.0425	ft./ft. (from Figure 2-6)
$h_{aq,avg.}$=	25	ft.
w=	800	ft. (width of known VOC plume)
l=	1500	ft. (length from upgradient edge of known VOC plume to BSB-A6)
Surf. Area	658000	sq. ft (area of known plume from BSB-A2, BSB-A3, and BSB-A6)
$Sw_{aq.}$=	1	
$\phi_{aq.}$=	0.25	

Viscosity of water equals 1 cp.

Volume of Water in Aquifer underlying known VOC plume

$Vw=V*\phi$

V=A*h=	16450000	ft^3
Vw=	4112500	ft^3

Flow Rate through Aquifer

q=K*A*(dH/dL)

q=	2409	ft^3 /day	at Kh_{aq}=1.0e-03 cm/sec
q=	12047	ft^3 /day	at Kh_{aq}=5.0e-03 cm/sec

Estimated Time Required to Achieve Standards at the Point of Compliance

After water has drained from tailings (see above), estimate that up to five flushes of the contaminated aquifer will be required to achieve standards at the point of compliance.

At Kh_{aq} = 1.0E-03 cm/sec

$t_{1\ flush}$=	1707	days=	4.7	years
$t_{5\ flushes}$=	23.4	years		

Total Time Estimate to Achieve Point of Compliance=	23.4	years

At Kh_{aq} = 5.0E-03 cm/sec

$t_{1\ flush}$=	341	days=	0.9	years
$t_{5\ flushes}$=	4.7	years		

Total Time Estimate to Achieve Point of Compliance=	4.7	years

CLARK TAILINGS TIME TO COMPLIANCE CALCULATIONS

Data/Assumptions:

Tailings

$\phi_{tlgs.}$=	0.3	
$Sw_{tlgs.}$=	0.6	(water saturation in tailings) Sw=(vol. of fluid in media)/(total vol. of voids)
$Sirr_{tlgs.}$=	0.12	(irreducible water saturation)
$Kv_{tlgs.}$=	0.035	ft/day(vertical perm. of tailings=.25 of Kh=$5*10^{-5}$cm/sec.)
$(dH/dL)_{tlg}$=	1	ft./ft. (approximate drainage gradient in unsaturated envrionment)

Capillary pressure effects in draining tailings can be neglected.

Non-uniform mixing will occur from tailings to alluvium/aquifer, but over time more uniform mixing will occur downgradient of the Clark Tailings site.

Viscosity of water equals 1 cp.

Alluvium Above Aquifer and Below Tailings

$Kv_{all.}$=	0.354	ft/day(vertical perm. of alluvium=.25 of Kh=$5*10^{-4}$cm/sec.)
$(dH/dL)_{all.}$	1	ft./ft. (approximate drainage gradient in unsaturated envrionment)
$h_{all, avg.}$=	25	ft.

Aquifer

$Kh_{aq.}$=	2.835	ft/day(horizontal perm. of aquifer=$1*10^{-3}$cm/sec.)
$Kh_{aq.}$=	14.173	ft/day(horizontal perm. of aquifer=$5*10^{-3}$cm/sec.)
$(dH/dL)_{aq.}$	0.0425	ft./ft. (from Figure 2-6)
$h_{aq,avg.}$=	25	ft.
w=	1100	ft. (width of flow through Clark Tailings, avg.)
l=	1500	
$Sw_{aq.}$=	1	
$\phi_{aq.}$=	0.25	

Volume of Water in Clark Tailings + LAO Tailings.

$V_{tlgs.}$=	54000000	ft^3 (Clark Tailings + LAO Tailings)
$A_{tlgs.}$=	2395800	ft^2 (55 acres)
$h_{tlgs,avg.}$=	22.54	ft.

$Sw=Vw/\phi*V_{tlgs.}$

Vw=	9720000	ft^3

Volume of Water in Clark Tailings + LAO Tailings which will Drain to Aquifer

Vw_{drain}=	(1-Sirr)*Vw	
Vw_{drain}=	8553600	ft^3

Velocity of Water Drainage from Clark Tailings + LAO Tailings to Aquifer

$q=K*A*(dH/dL)$

$q=v*A$

Assume lowest K drives drainage.

At dH/dL =1 ft./ft. , velocity=permeability

v=	0.035	ft/day

$h_{total}=h_{tlgs.}+h_{all.}$

h_{total}=	47.5	ft.

Time Required for Water to Drain from Tailings to Aquifer

$h_{total}=v*t$

t=	1342	days =	3.7	years

Volume of Water in Aquifer underlying Clark/LAO Tailings

$Vw=V*\phi$

V=A*h=	59895000	
Vw=	14973750	ft^3

Flow Rate through Aquifer

$q=K*A*(dH/dL)$

q=	3313	ft^3 /day	at Kh_{aq}=1.0e-03 cm/sec
q=	16565	ft^3 /day	at Kh_{aq}=5.0e-03 cm/sec

Estimated Time Required to Achieve Standards at the Point of Compliance

After water has drained from tailings (see above), estimate that five flushes of the aquifer underlying Clark/LAO tailings will be required to achieve standards at the point of compliance.

At Khaq = 1.0E-03 cm/sec

$t_{1\ flush}$=	4520	days=	12.4	years
$t_{5\ flushes}$=	61.9	years		

	Total Time Estimate to Achieve Point of Compliance=	65.6	years

At Khaq = 5.0E-03 cm/sec

$t_{1\ flush}$=	904	days=	2.5	years
$t_{5\ flushes}$=	12.4	years		

	Total Time Estimate to Achieve Point of Compliance=	16.1	years

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